Dobbins Creek – SWAT Model

Agricultural Watershed Restoration Grant Project

Prepared For
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Executive Summary

Dobbins Creek watershed is part of the CRWD located in southern Minnesota. The watershed is northeast of the city of Austin, Minnesota and is entirely contained in Mower County. The Dobbins Creek watershed area is approximately 38 square miles (24,550 acres). The creek is approximately a 26-mile stream divided into three branches: North Branch, South Branch and Unnamed Branch. The creek ranges in width by of approximately 13 – 16 feet, (CRWD, 2008). The creek empties into East Side Lake, which then drains to the Cedar River.

The CRWD, in partnership with the Minnesota Board of Water and Soil Resources (BWSR), have undertaken the development of a Soil and Water Assessment Tool (SWAT) model for the Dobbins Creek watershed system. The scope of this project is to use SWAT to simulate hydrologic and sediment dynamics on a continuous simulation to identify potential system changes or Best Management Practices (BMPs) needed to meet sediment water quality standards in the Dobbins Creek Watershed, specifically in the impairment reach.

This report is a summation of the application of the SWAT model and evaluation of load reduction scenarios. The report is divided into the following sections:

Executive Summary – Provides an overview of the report

Project Background – Summarizes the historic background of the project documenting the fact that Dobbins Creek is impaired for turbidity and that the scope of this project is to simulate hydrologic and sediment dynamics on a continuous simulation to quantify the impact that potential system changes or BMPs would have on the hydrology and sediment impairment within the watershed.

Watershed Characteristics – Presents current information about the watershed relating to land use/ land cover, topography, soils, hydrology and farming practices.

Model Selection, Development and Performance – Describes the selection method used to select a SWAT model as the preferred modeling tool for this watershed; how and where data were compiled from and an assessment of the available data; and how the model was calibrated and validated.

Evaluation of Load Reduction Scenarios – Presents five load reduction scenarios: Existing Conditions/ Do Nothing, Temporary Distributed Storage, Perennial Vegetation, Erosion Control and a combination of BMPs used in the other scenarios. These scenarios were described, computed, water quality benefits presented, estimated cost offered and concluded with an assessment of implementation challenges.

Conclusion – Summarizes the project and provides recommendations.

Project/ Modeling Framework

Model Selection

To complete the project, the Hydrological Simulation Program – Fortran (HSPF), the Agricultural Non-Point Sources Pollution Model (AGNPS) and the SWAT models were evaluated for use on this project. The models were evaluated based on the following:

- Public domain/private software
- Event Based/ continuous simulation
- Empirical/physically based
- Geographical Information System (GIS) based models

After reviewing the list of available watershed data and the scope of the project, which requires a model that simulates nutrient and sediment dynamics on a continuous basis, and the intended use of the model, SWAT emerged as the most suitable model.

Model Development

The model was developed in three major steps. These steps were completed as follows and are summarized described below:

1. Compile Data
2. Model Construction
3. Perform Model Calibration and Validation

Data Assessment

Various sources of data were available for land use, soils, topography, climate, land management, stream flow, water quality and infrastructure, as described above. Stream flow and sediment data were the most limited. Stream flow data were reviewed from the Minnesota Department of Natural. Although it was documented that flow data are available from 1998 – present for gauge station DNR 48005001, only data from 2008 and 2009 were used to calibrate and validate the model due to data quality. Datasets used for sediment calibration were from July and August 2000 and July and August 2001. Although there are data gaps, the key to making the most successful use of a SWAT model for the Dobbins Creek watershed was to calibrate the model to observed, monitored flow and sediment data.

Model Construction

The model was constructed in three key steps: watershed delineation, land use, and soils integration. The watershed delineation was completed by loading the Digital Elevation Model (DEM) into SWAT. Thirty-seven (37) subbasins and the outlet to the Cedar River were defined. The land use and soil themes were defined by loading the National Land Cover Data (NLCD) land use and Soil Survey Geographic (SSURGO) soil data layers. Once each subbasin was defined they were furthered divided into Hydrologic Response Units (HRU). After the HRUs were developed, land management practices, such as fertilizer application, crop rotations, and tillage operations were added. Lastly, climate data were added and the model was executed/simulated using a model default coefficient.

Model Performance

SWAT simulated results were compared to observed data to determine whether the model simulations provide a reasonable representation of actual conditions. The model was calibrated and validated to available flow and sediment concentration data. Flow data from the DNR 48005001 were divided and used for model calibration and validation as noted below.

Calibration	Validation
April 08	May 08
June 08	July 08
August 08	September 08
October 08	November 08
April 09	

Sediment data from the J.C. Hamel Nature Center site, just upstream of East Side Lake for the 2000-1 monitoring period were divided and used. Data from July and August of 2000 were used for calibration, and data from July and August 2001 were used for validation. The SWAT model parameters adjusted to calibrate the model are presented in Table E1:

Table E1: Dobbins Creek Model Calibration Parameters

Parameter	Definition	Units	Lower Bound	Upper Bound	Default	Calibrated Model
Flow						
ALPHA_BF	Baseflow alpha factor for recession constant	days	0	1	0.048	0.7
CH_K2	Effective hydraulic conductivity in tributary channel	mm/hr	0	25	0	12
CH_N	Manning's roughness coefficient for the main channel		0.014	.024	0.014	0.019
CN2	SCS runoff curve number		-0.05	0.05	Varies	0.05
ESCO	Soil evaporation compensation factor		0	1	0	1
GW_DELAY	Groundwater delay	Days	0	31	31	16
GWQMN	Threshold depth of water in the shallow aquifer from return flow	mm	-2000	2000	0	-1457.17

Parameter	Definition	Units	Lower Bound	Upper Bound	Default	Calibrated Model
REVAPMIN	Threshold depth of water in the shallow aquifer for revap or percolation to the deep aquifer to occur	mm	-100	100	1	8.264
SMTMP	Snowmelt temperature	°C	-0.25	.25	1	-0.12
SOL_AWC	Available water capacity	m/m	-0.25	.25	Varies	0.195
SURLAG	Surface runoff lag coefficient		0	10	4	0.5
TIMP	Snow pack temperature lag factor		0	1	1	0.687
Sediment						
SPEXP	Exponent parameter for calculating sediment re-entrained in channel sediment routing		1	2	1	2

This model's performance, using a daily time step, had R^2 values of 0.7 and 0.7 for flow calibration and validation and 0.9 and 0.8 for sediment calibration and validation, respectively.

Load Reduction Scenarios

A. Existing Condition
B. Temporary Distributed Storage (Flood Reduction Sites, Wetland Restoration Sites and Temporary Distributed Storage Sites)
C. Perennial Vegetation (Converting Corn and Soybean crops to Switchgrass throughout the watershed)
D. Erosion Control (Conservation Tillage, and Newberry Rock Riffles)
E. Combination (Flood Reduction Sites, Wetland Restoration Sites and Temporary Distributed Storage Sites, and Conservation Tillage)

Conclusion

The CRWD, in partnership with BWSR, undertook the application of a SWAT model to model the Dobbins Creek watershed system. The scope of this project was to use SWAT to simulate hydrologic and sediment dynamics on a continuous simulation to identify potential system changes or BMPs needed to meet TSS water quality standards in the Dobbins Creek Watershed. Using the calibrated SWAT model, five broad scenarios were evaluated to determine their ability to reduce peak flows and TSS transported through the Dobbins Creek system. The primary focus of this project was sediment reduction; however, best management practices selected for implementation under these scenarios also considered their ability to reduce peak flow.

The goal of these scenarios, as documented by CRWD, is to meet applicable turbidity/TSS state surface water quality standards. Dobbins Creek is a class 2B stream with a turbidity limit of 25 NTUs which translated to between 30 – 40 mg/l of TSS. The three branches of Dobbins Creek, North, South and Unnamed, were examined using the calibrated model to determine if those reaches were meeting current water quality standards based on monthly averages of TSS concentrations over a 10-year period (1999-2008). The South Branch consistently meets water quality standards. While the Unnamed Branch, violates the standard by about 5 mg/l one month over the 10-year period. On the other hand, North Branch violates the water quality standard five times over the 10-year period with exceedance of the standard ranging from about 7 mg/l to 35 mg/l. As a result, the focus of BMP implementation was the North Branch of Dobbins Creek. The five (5) scenarios are summarized below.

A. Existing Condition - This scenario called for CRWD, residents and stakeholders to maintain existing practices (crop rotations, land management, and fertilizer application). This scenario documented no improvement to infrastructure, farming practices or the main/tributary channels. As a result, North Branch and Unnamed Branch do not meet TSS water quality standards.

B. Temporary Distributed Storage – This scenario implement seven wetland restoration sites identified by CRWD, two sites from Flood Reduction Feasibility Studies, and seventeen(17) temporary storages sites from the WMP. The principal goal of this scenario was to reduce the continuous simulated peak flows (for the 10-year period) by 10 percent. Again, the focus of this goal was not to meet the water quality standard but the reduce peak flows by 10 percent. Implementing this scenario provided a 10 percent reduction in continuous simulated peak flows from Scenario A. TSS concentrations reduced by 4-5 percent in some months and in others by 50 – 70 percent. Although there were reductions in TSS concentrations, they were not enough the meet water quality standards. The cost to implement this scenario would be approximately $2.1 million. The primary challenge to implementing this scenario is financial and public perception. The flood reduction sites and the wetland restoration sites will require a substantial capital investment from CRWD to acquire properties, design and construct. Also, public perception surrounding down sizing culverts to manufacture temporary storage areas has not been favorable. The scale of the WMP was so larger that stakeholders were unwilling to consider. However, the reduced magnitude presented here may be more palatable.

C. Perennial Vegetation: The goal of this scenario was for the watershed to meet TSS water quality standards. To meet TSS water quality standards, 100 percent of the agricultural land in the North Branch subwatershed was converted from corn or soybean crops to switchgrass. The cost to implement that conversion would be about $4 million. Result from the survey indicated that farmers in this region are less likely to convert from corn or soybeans to switchgrass/perennials. In addition, the programming cost necessary to offset the annual loss in revenue is high relative to the CRWD 2010 – 2018 average annual operating budget of $880,444 (Cedar River Watershed District, 2009).

D. Erosion Control: The following erosion control best management practices were implemented in this scenario to meet TSS water quality standard: conservation tillage and stream bank restoration. Conservation tillage was employed over 100 percent of agricultural land draining to the North Branch. In addition, streambanks within the North Branch would be restored though revetment projects along the entire 1,014 m (3,328 ft) length of the channel from East Side Lake. Then, Newberry Rock Riffles were implemented in stream sections (1, 7, 10, 12, 17, 22, and 25) to control grade, reduce velocity and trap sediment. The cost of implementation is about $ 790,311. As with Scenario B, the implementation challenge is financial. CRWD would need funds to pay for engineering design and construction services associated with the Newberry Rock Riffles; and to buy the items need for the riparian restoration/streambank stabilization.

E. Combination: The practices considered in this scenario were based on responses received from the surveys; the ability of these practices to meet TSS water quality standards, reduce peak flows by 10 percent; and the availability of grant programs to offset the financial burden. Using that as a basis, the following practices were used in Scenario E:

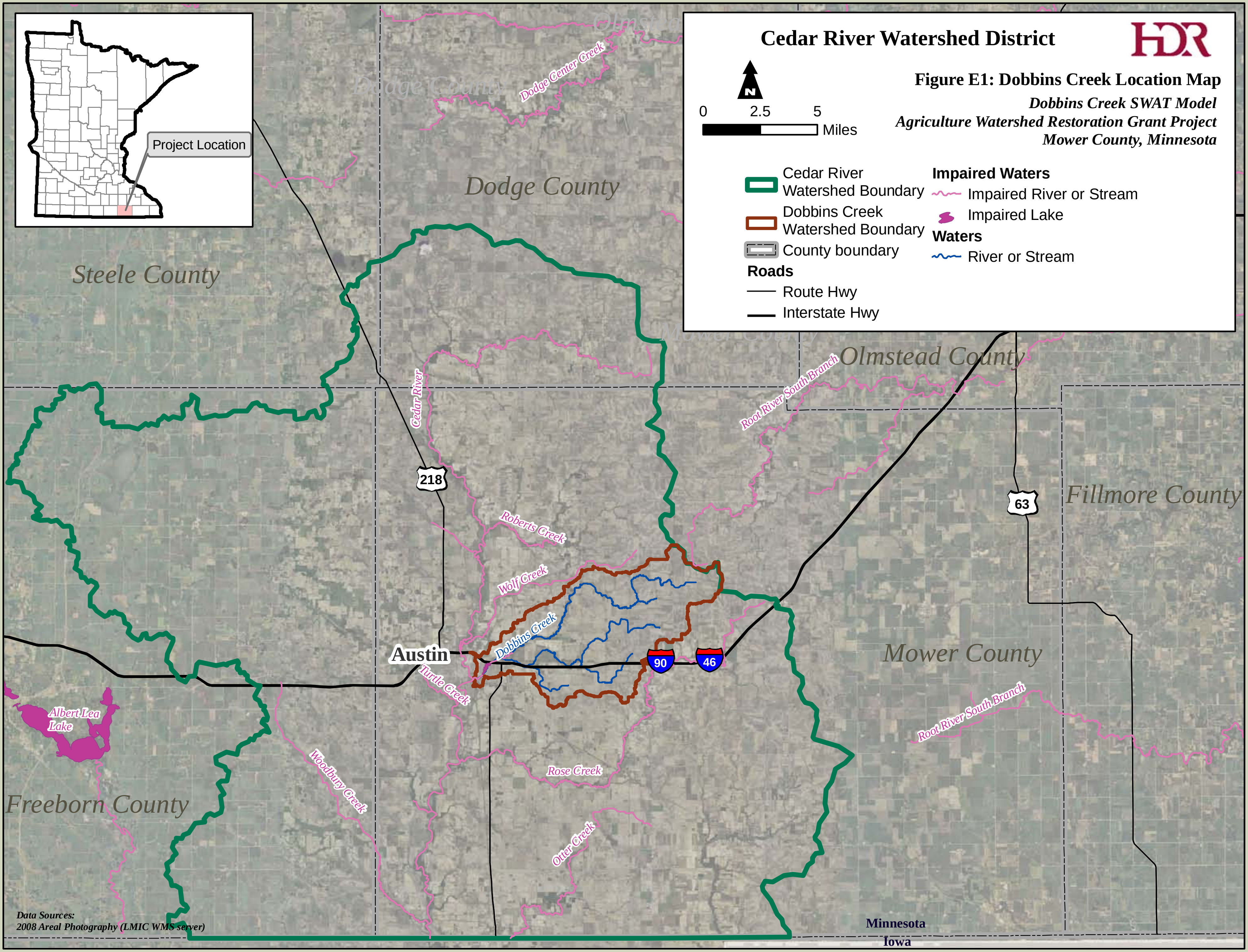
- Flood Reduction Sites
- Wetland Restoration Sites
- Phase 1- Temporary Storage Sites (Table 10)
- Conservation Tillage

Over the 10-year period of record, monthly average TSS concentrations values were reduced by 34 percent, which satisfied Minnesota Statue 7050. In addition, peak flow readings were reduced by 23 percent. The cost to implement this scenario is about $2 million. Although, the price tag is high, there are several grants and funding mechanisms available to CRWD to offset the cost. This scenario is practical because it builds on previous studies, it has support from stakeholder and it addresses both water quality and quantity concerns. It is feasible because the BMPs suggested here and the results of this report provide CRWD the framework and evidence needed to gain financial support.

Recommendations

Considering the findings presented in this report and the water quality implications to Dobbins Creek, the following actions are recommended:

- Apply for Phase 3 funding and other applicable funding to implement Scenario E. Use the funds received to
    1. Revise Site 1 and 2 Flood Reduction designs to incorporate water quality features
    2. Complete Phase 1 site assessments/feasibility studies on the seven (7) identified wetland restoration sites.
    3. Complete engineering design and construction associated with the WMP temporary storage sites incorporated in the study.
- Complete an in-depth water quality study of East Side Lake to determine nutrient and sediment budgets.
- Continue monitoring efforts and integrate procedures that will aide obtaining flow and TSS data during high flow events.
- Education and engage stakeholders to voluntarily participate in runoff reducing practices, such as, conservation tillage or no-till.



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Project Background

The Cedar River Watershed District (CRWD) is located in Steele, Dodge, Freeborn, and Mower Counties, Minnesota. The primary land mass is contained within Mower County. The CRWD drainage area is approximately 435 square miles and contains eleven stream reaches: Dobbins Creek, Lower Cedar River, Mud Lake Creek, Orchard Creek, Roberts Creek, Rose Creek, Schwerin Creek, Upper Cedar River, West Beaver Creek, Wolf Creek, and Woodbury Creek. The focus of this project is the Dobbins Creek stream reach. Dobbins Creek and its contributing watershed were selected as part of a state-wide project for agricultural watershed restoration and management focusing on hydrology and water quality. The watershed was selected because of water quality concern, the land use is predominantly agricultural, and due to its size.

The CRWD, in partnership with the Minnesota Board of Water and Soil Resources (BWSR), have undertaken the application of the Soil and Water Assessment Tool (SWAT) to model the Dobbins Creek watershed system. The scope of this project is to use the SWAT model to simulate hydrologic and sediment dynamics on a continuous simulation to identify potential system changes or Best Management Practices (BMPs) needed to meet turbidity (total suspended sediment) water quality standards in the Dobbins Creek.

The following sections describe the Dobbins Creek watershed model including: model selection, application and performance; and use for various scenarios.

Watershed Characteristics

Dobbins Creek watershed is part of the CRWD located in southern Minnesota. The watershed is northeast of the city of Austin, Minnesota and is entirely contained in Mower County. The Dobbins Creek watershed area is approximately 38 square miles (24,550 acres). The creek is approximately a 26-mile stream divided into three branches: North Branch, South Branch and Unnamed Branch. The creek ranges in width by of approximately 13 – 16 feet, (CRWD, 2008). The creek empties into East Side Lake, which then drains to the Cedar River.

According to water quality assessments completed by the MPCA, Dobbins Creek has fecal coliform water quality impairment from township 103 north, section 26, range 18 west, east line to Cedar River. The impaired section is not meeting the water quality standards set for fecal coliform which is 126 E.Coli colony forming units per 100 ml (US EPA, 2008). As a result in 2006, that section of Dobbins Creek was put on the 303 (d) list (MPCA, 2006). A total maximum daily load (TMDL) has been completed and is being implemented as part of the Lower Mississippi River Basin process (CRWD, 2008). Currently, Dobbins Creek is being assessed for turbidity impairment. The assessment process entails the MPCA calling for available data along the creek to determine if the creek is meeting the turbidity water quality standard of 25 nephelometric turbidity units (NTU) or total suspended solids (TSS) of 40mg/L (Thompson - Personal Communication, 2009). A review of available data, which will be discussed in a later section, suggests that the reach of the creek north of

East Side Lake is not meeting water quality standards for turbidity. The primary focus of this study, as previously stated, is to determine potential BMPs needed for the creek to meet turbidity/ TSS water quality standards.

Below is a brief description of the characteristics of Dobbins Creek Watershed.

Land Use/Land Cover

According to the National Land Cover Dataset (NLCD), land use within the watershed is approximately 80 percent agricultural with the remaining 20 percent divided between forest, range, wetlands, residential and industrial land uses (Figure 1) (USGS, 2001).

Topography

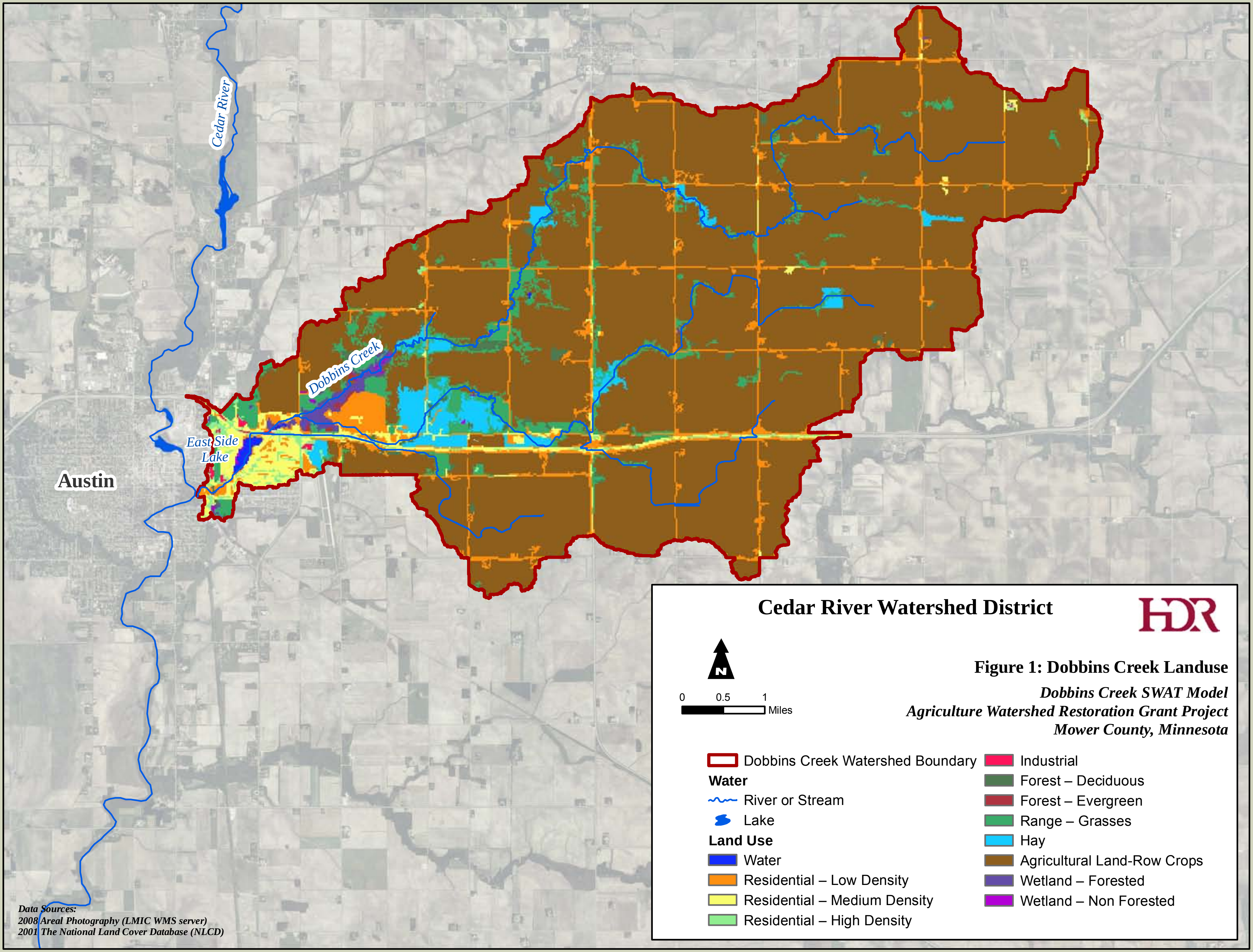
The watershed has an undulating topography. Relief in the watershed ranges from 1410 feet to 1174 feet above mean sea level (Figure 2).

Soils

There are three predominate soil associations in the Dobbins Creek Watershed: Marchan-Waukee-Hayfield, Sargeant-Brownsdale-Skyberg and Tripoli-Oran-Readlyn. Soils within the watershed are generally poorly to somewhat poorly drained. Small patches of sand loam and clay loam soils are present within the central and northeast parts of the watershed, which are moderately to poorly drained, respectively. Similarly, most of the soils have medium to low infiltration.

As stated in the Mower County Soil Survey, soils in the area were formed is silty sediment overlaying glacial till, sandy glacial till, recent alluvium or thin loamy sediment overlaying weathered limestone bedrock (Carroll R Carlson (Soil Consrevation Service), 1989).

These prevailing soils associations were captured in Natural Resources Conservation Service (NRCS) U.S. General Soil Map (STATSGO2) database and are presented on Figure 3. Until 2006, these data were referred to as the State Soil Geographic (STATSGO) database. It consists of a broad based inventory of soils and non-soil areas. STATSGO2 provides a general overview of the soils in the project area. For use on this project, the Soil Survey Geographic (SSURGO) dataset was used as discussed under Model Application.



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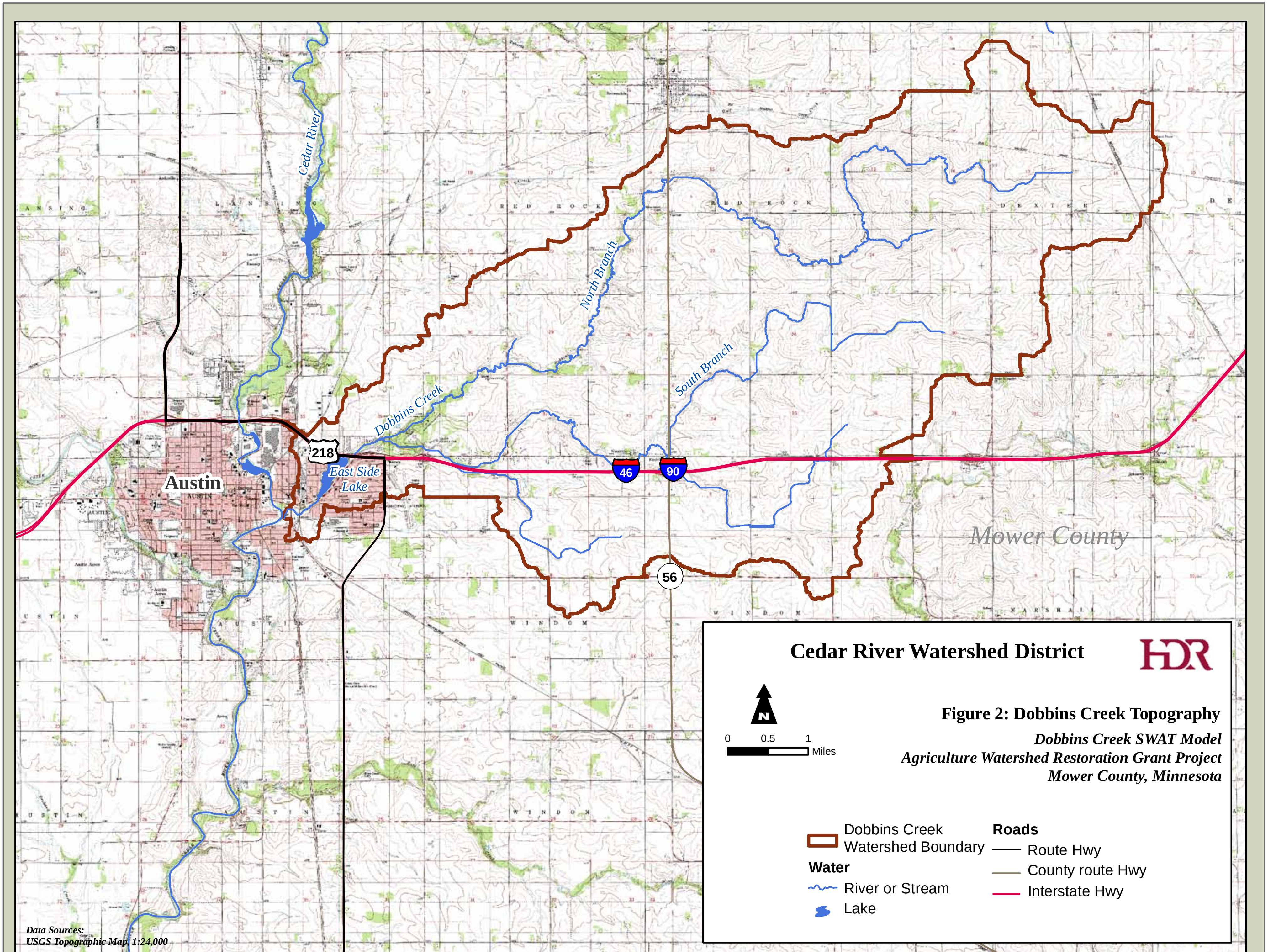

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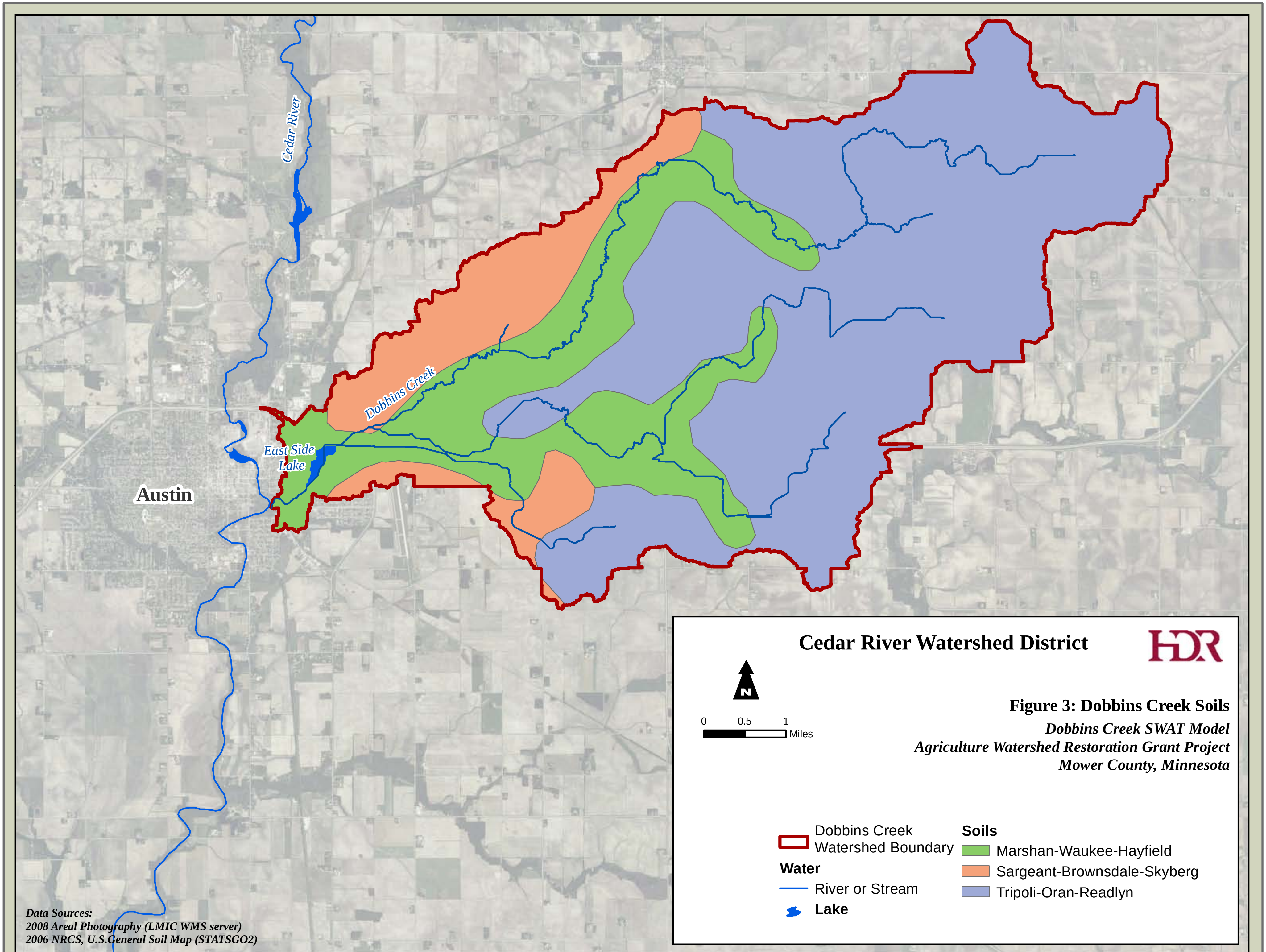

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Hydrology

The hydrology of the Dobbins Creek watershed is a flashy, complex system with a few tributaries interconnecting from surrounding agricultural areas, tile drainage and drainage ditches. The North, South and Unnamed branches of Dobbins Creek drain the northern part; and the central and southern parts of the watershed, respectively (Figure 4). Beginning at stream mile eight (8) and stream mile seven (7) northeast of the city of Austin, the North and South branches meander southwest into Austin and flow together in the J.C. Hormel Nature Center. Dobbins Creek flows about 0.5 miles before discharging to East Side Lake (Bednar, 1993).

Farming Practices

As previously mentioned, land use within the watershed is predominately agricultural. Farming practices associated with agricultural land use generally consists of a rotation of corn and soybeans. The rotations for the 2006, 2007, and 2008 growing seasons by percentage of the agricultural land use watershed area are shown in (Table 1) (United States Department of Agriculture - NASS). Table 1 illustrates, for example, that same areas of agricultural land totally 36 percent in Dobbins Creek were cropped on a corn (2006), soybean (2007), corn (2008) rotation.

Approximately 96 percent of the agricultural land use was farmed using a few different combinations of corn and soybean rotations as shown in Table 1. For the remaining four (4) percent of the agricultural land use, over 62 other crops and rotations were used. Chisel plow is the main tillage practice used throughout the watershed (Hanson, Dobbins Creek Land Management, 2009). Fertilizer (including manure) is used within the watershed; however it is typically only applied to corn crops (Table 2).

Table 1. Dobbins Creek Agricultural Land Use Crop Rotation for 2006, 2007 and 2008[1]

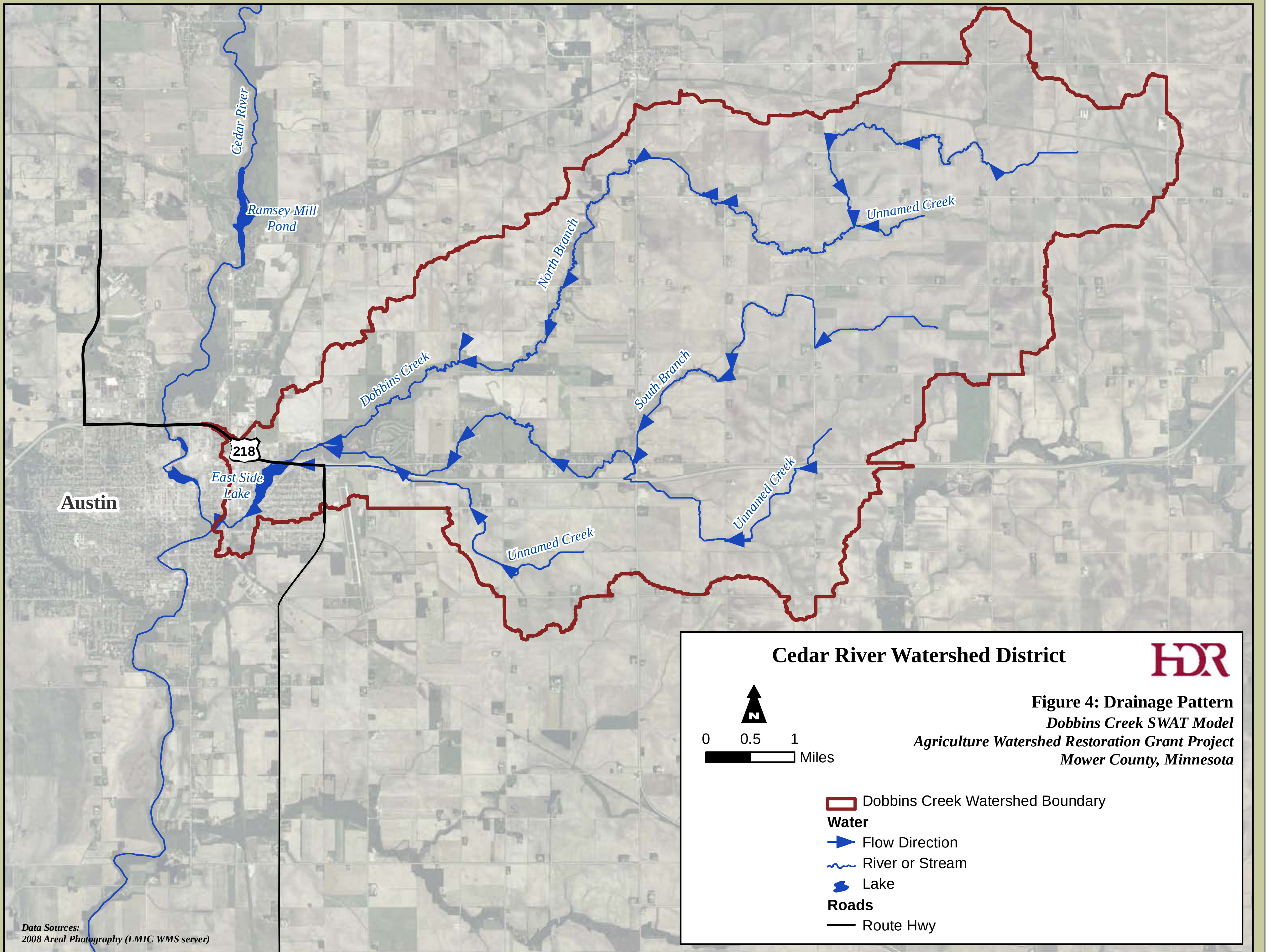
Crop Rotation by Annual Crop Type (2006-2007-2008)	Percentage of Agricultural Land Use Area
Corn-Soybean-Corn	36
Soybean-Corn-Soybean	33
Soybean-Soybean-Corn	9
Soybean-Soybean-Soybean	6
Corn-Soybean-Soybean	4
Corn-Corn-Corn	3
Corn-Corn-Soybean	3
Soybean-Corn-Corn	2
Total	**96**

[1] (United States Department of Agriculture - NASS)

Table 2. Dobbins Creek Fertilizer Application[2]

Fertilizer	Application rate (lbs/acre)	Application Area, (acre)	Annual Load (lbs)
Anhydrous Ammonia (82-0-0)	125	12,425	1,553,125
Urea (46-0-0)	20	4,142	82,840
DAP (non manure applicants)	50	16,566	828,300
Starter (at planting)	5	18,637	93,185
Pot Ash 2 (non manure applicants)	40	16,566	662,640
Manure	4,000 gal/ac	4,142	16,568,000 gal

[2] (Hanson, Dobbins Creek Land Management, 2009)



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Model Selection, Development, and Performance

Model Selection

A range of simple to detailed hydrologic and water quality models are available. Many of these are public domain models, developed and supported by various government agencies. Private models, for sale by software companies, are also available. Drawbacks with private models include the cost, technical support, and limited access to the technical underpinnings. Many of the public domain models are summarized in the Environmental Protection Agency (EPA) *Draft* Handbook for Developing Watershed TMDLs (US EPA, 2008).

While many of these models do not readily integrate geographic information system (GIS) data to calculate the loadings, most of the data needed and available to produce a defensible model and simulate a variety of scenarios are in a GIS format, or would be determined using GIS coverages. Based on the preference of using a pubic domain model and the requirement to use a tool that directly integrates GIS data, the list of potential models for selection was greatly reduced. The most promising models are Agricultural Nonpoint Sources (AGNPS), Hydrological Simulation Program - Fortran (HSPF), and SWAT. After reviewing the list of available watershed data, the scope of the project—which requires a model that simulates sediment dynamics on a continuous basis—and by evaluating the intended use of the model, SWAT emerged as the most suitable.

SWAT is a quasi-physically-based water quality simulation model that operates internally on a daily time step. It is a basin-scale model developed by United States Department Agriculture (USDA) - Agricultural Research Service (ARS), in Temple, Texas (Neitsch, Arnold, Kiniry, & Williams, 2005). SWAT was developed to predict the impact of land management practices on water, sediment, and agricultural chemical yields in complex watersheds with varying soils, land use, and management conditions over long periods of time. The SWAT model components include: hydrology, weather, sedimentation, crop growth, nutrients, pesticides, and agricultural management. To accurately predict movement of sediment, nutrients, and pesticides, the hydrologic cycle, as simulated by the model, must conform to what is happening in the watershed.

The strength of the SWAT modeling approach is in the emphasis on landscape scale analysis of pollutant loadings with a powerful GIS-based interface. This yields a direct association between land use activities and water quality impacts to engage stakeholders in management efforts. The SWAT model also provides a focal point for a unifying assemblage of data, a detailed understanding of the source of pollutants, an ability to simulate existing and future scenarios, and a foundation for analyzing adaptive management efforts to improve water quality with time.

Model Development

The model was developed in three major steps. These steps were completed as follows and are described in more detail below:

1. Compile Data
2. Model Construction
3. Perform Model Calibration and Validation

Data Compilation

Available monitoring data are critical to constructing a watershed model which accurately simulates movement of sediment, nutrients, and the hydrologic cycle of the Dobbins Creek watershed. Data were compiled from CRWD, and various state and federal agencies as described below. These data were reviewed and evaluated for use in constructing a credible and defensible model of the watershed. The following sections summarize data compiled for the Dobbins Creek Watershed SWAT model and the respective sources for data from the 10-year period from 1999 through 2008.

Climate

Climate data were obtained from the Minnesota Climatology Historical Climate Data Retrieval system (Historical Climate Data Retrevial, 2009). Data for maximum and minimum daily air temperatures and precipitation were available for National Oceanic Atmospheric Administration (NOAA) monitoring station 210355 – Austin 3S, latitude 43.62252/longitude 93.00581. This monitoring station was selected because of its proximity to the watershed. Data acquired are discussed in a later section.

Topography

The Department of Natural Resources (DNR), on behalf of the 2007 Minnesota Recovers Task Force and its local, state and federal partners conducted a project to collect light detection and ranging (LIDAR) data across the seven counties (including Mower County) identified as federal disaster areas after the August 2007 floods in southeastern Minnesota (DNR, 2009). For this project CRWD provided LIDAR data, clipped to the Dobbins Creek watershed, in the form of a digital elevation model (DEM) raster dataset. The dataset had 2-foot contour feature class and hill shade raster within an Environmental Systems Research Institute, Inc (ESRI) file geodatabase. The data provided had a mean point density of 1.5 meters, a horizontal accuracy of less that 1 meter and a vertical accuracy of 18 centimeters or less. The LIDAR data were projected in universal transverse mercator (UTM) Zone 15 coordinate system, North American Datum of 1983 (NAD83) horizontal datum and North American Vertical Datum of 1988 (NAVD88) vertical datum (Figure 5).

Soils

The Natural Resources Conservation Service (NRCS) Division of the USDA maintains a database of soils data. This database is referred to as the Soil Survey Geographic (SSURGO) dataset (USDA-

SSURGO). The SSURGO dataset is the most detailed soil mapping produced by the NRCS. The soils coverage was projected in the NAD 1983 UTM Zone 15N (Figure 6).

Land Use/ Land Cover

The National Land Cover Database (NLCD) coverage from 2001 was acquired from the United States Geologic Survey (USGS) Multi-Resolution Land Characteristics Consortium (MRLC) (USGS, 2001). NLCD data consists of land use and land cover classification data primarily based on interpretation of aerial photography and elevation data. Coverage for the NLCD area includes several class codes used to identify land use and land cover. The most common NLCD coverage in the Dobbins Creek watershed is agricultural. The data were projected in NAD 1983 UTM Zone 15N (Figure 1).

Land Management

Crop cover data were obtained from the National Agricultural Statistics Service (NASS) for 2006, 2007 and 2008 as a raster data file projected in the NAD 1983 UTM Zone 15N coordinate system. The vast majority of the watershed was farmed as corn or soybean (Table 1). CRWD staff interviewed local farmers, farm managers, and NRCS local conservation personnel about tillage, fertilizer, and manure applications. A summary of the results from the interviews is shown in Table 3 (Hanson, Dobbins Creek Land Management, 2009). According to the data from the Minnesota Pollution Control Agency (MPCA), there are 32 registered feedlots located within the Dobbins Creek watershed (Hanson, Dobbins Creek Land Management, 2009). Information on feedlot location, size, and livestock information are presented in Table A1 in the Appendix A and Figure 7 (Hanson, Dobbins Creek Land Management, 2009).

Table 3. Dobbins Creek Watershed Tillage and Fertilizer Application Data

<table>
<tr><th colspan="4">Tillage Practice</th></tr>
<tr><td>Chisel Plow</td><td colspan="3">Spring
Fall after harvest</td></tr>
<tr><th colspan="4">Fertilizer Application</th></tr>
<tr><th>Name (Formula)</th><th>Application Rate</th><th>Application Period</th><th>Crop Application</th></tr>
<tr><td>Anhydrous Ammonia (82-0-0)</td><td>125 lbs/ac</td><td>Spring</td><td>Corn</td></tr>
<tr><td>Manure</td><td>4,000 gal/ac</td><td>Spring</td><td>Corn</td></tr>
<tr><td>Urea (46-0-0)</td><td>20 lbs/ac</td><td>Spring</td><td>Corn</td></tr>
<tr><td>DAP1(18-46-0)</td><td>50 lbs/ac</td><td>Spring (75%)
Fall (25%)</td><td>Corn</td></tr>
<tr><td>Starter (10-34-0)</td><td>5 lbs/ac</td><td>Spring</td><td>Corn</td></tr>
<tr><td>Pot Ash (0-0-60)</td><td>40 lbs/ac</td><td>Spring</td><td>Corn</td></tr>
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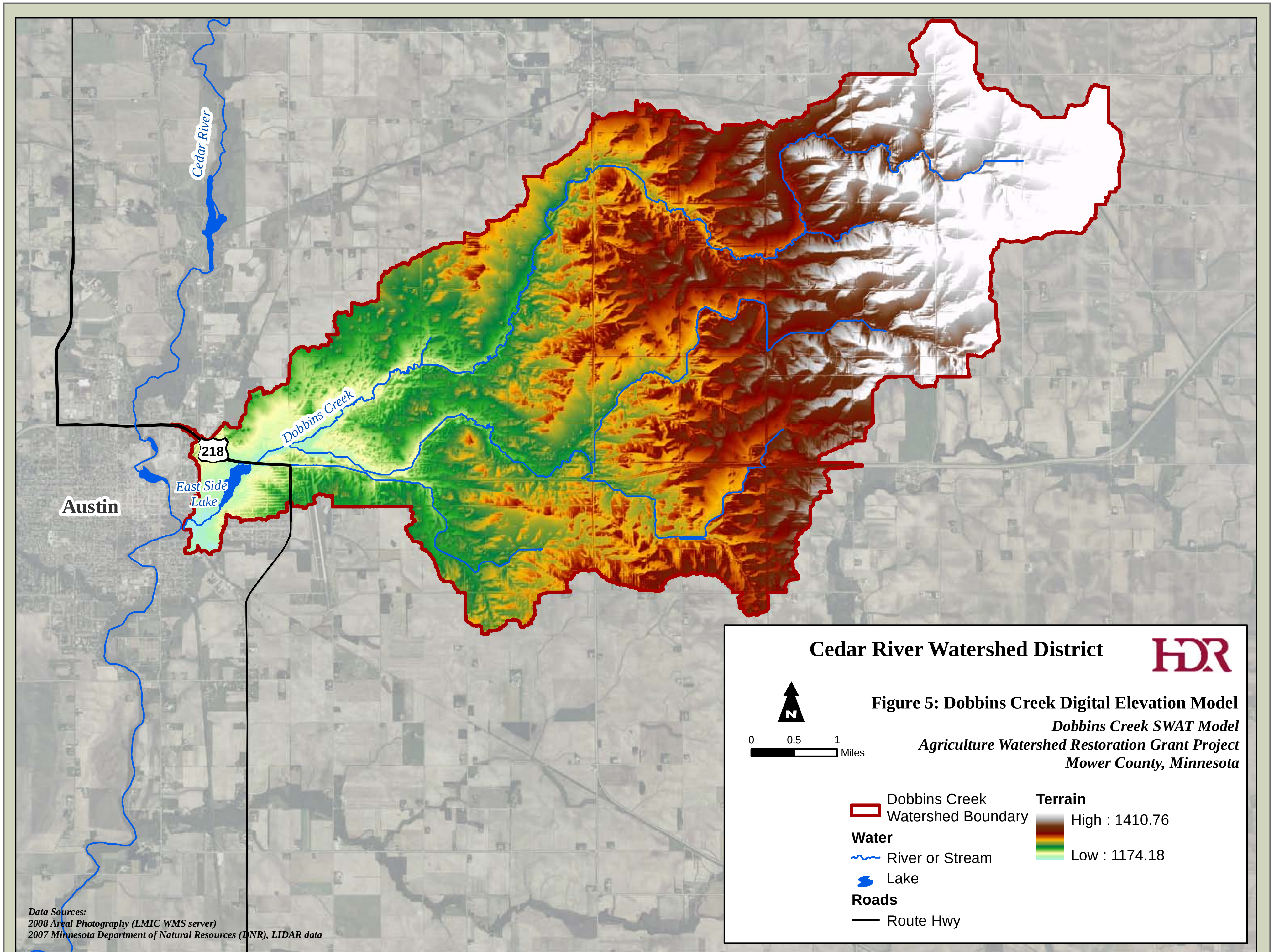

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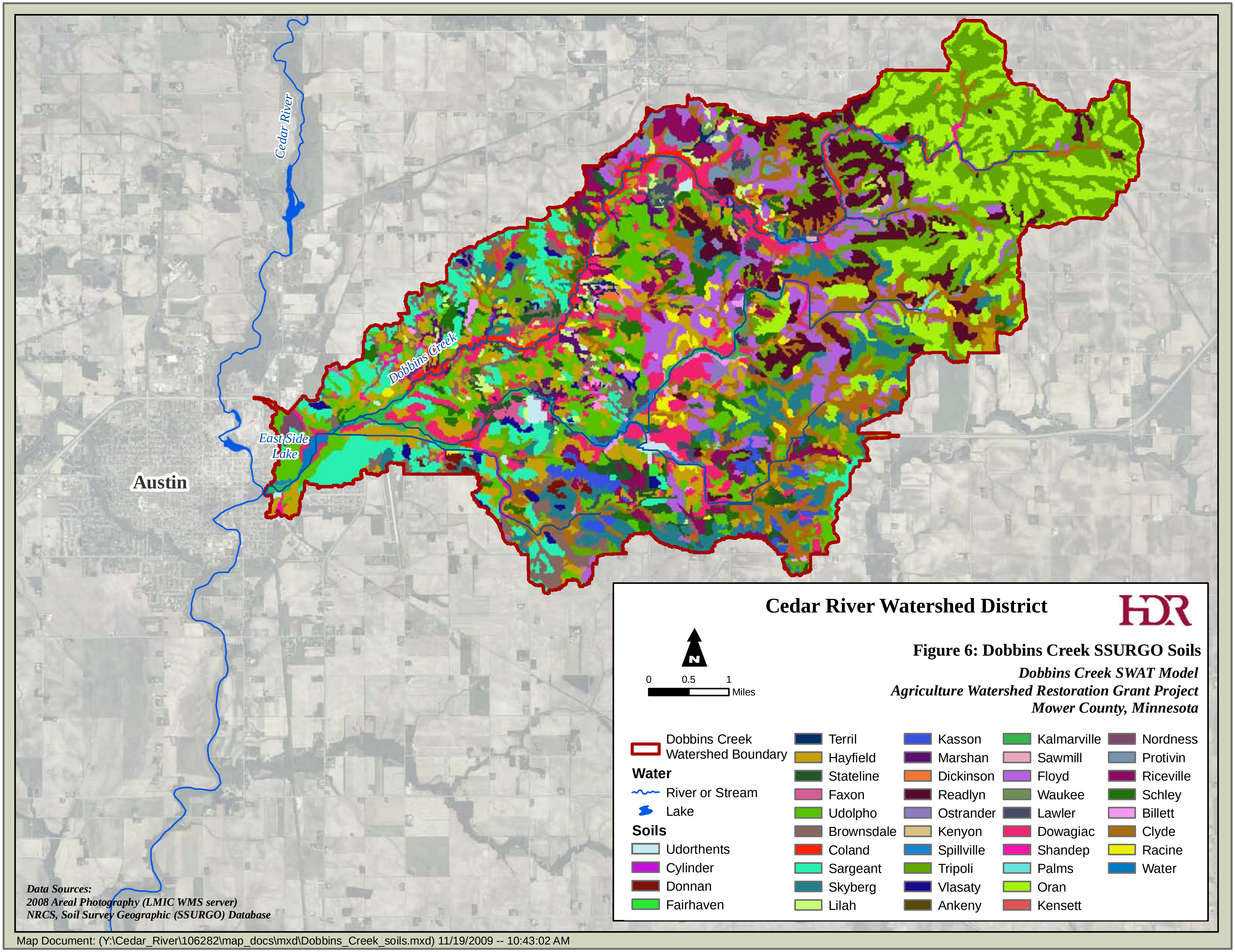
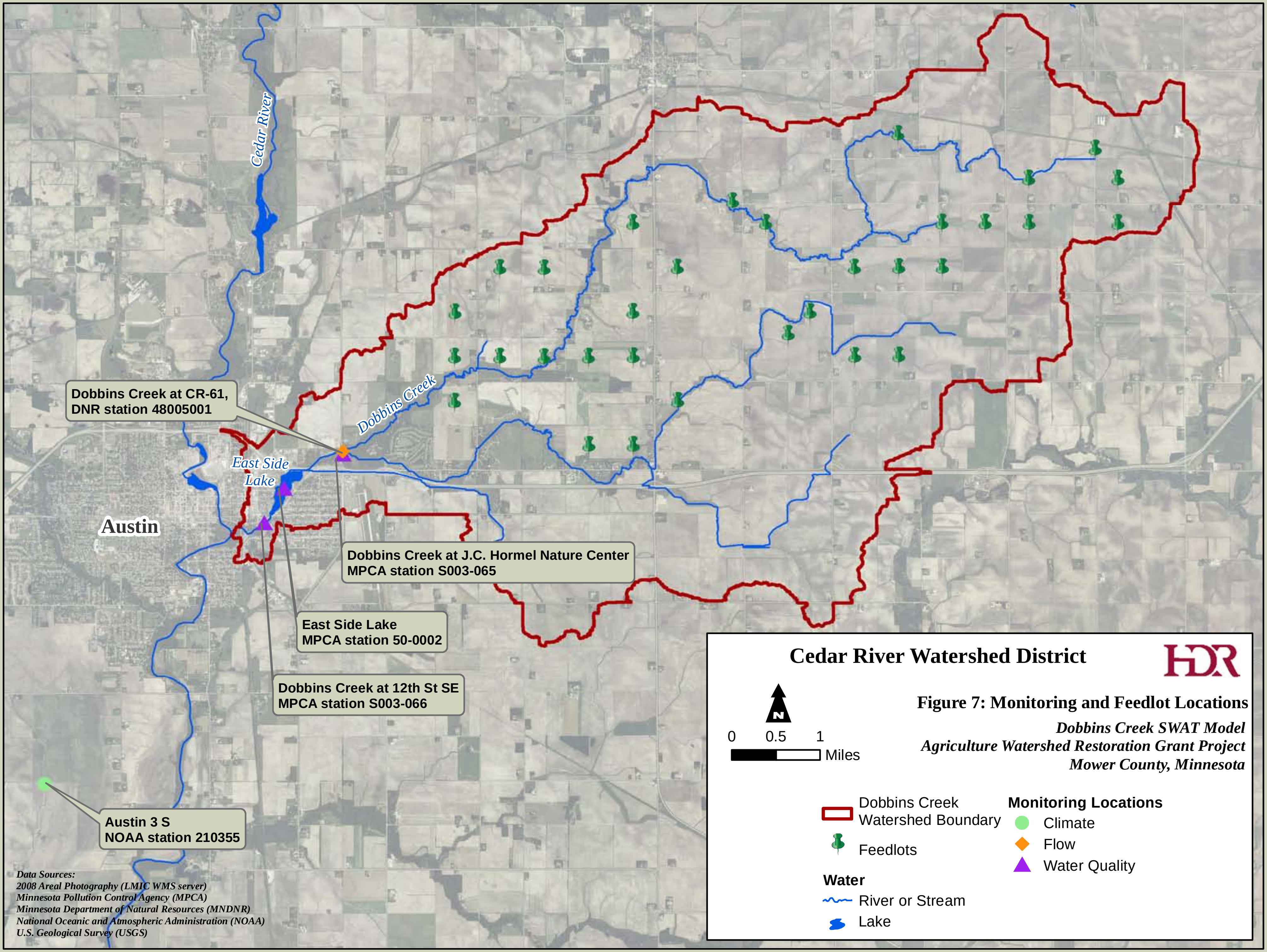

Cedar River
Dobbins Creek
East Side Lake
Austin
Cedar River Watershed District
HDR
N
0 0.5 1 Miles
Figure 6: Dobbins Creek SSURGO Soils
Dobbins Creek SWAT Model
Agriculture Watershed Restoration Grant Project
Mower County, Minnesota
Dobbins Creek Watershed Boundary
Water
River or Stream
Lake
Soils
Udorthents
Cylinder
Donnan
Fairhaven
Terril
Hayfield
Stateline
Faxon
Udolpho
Brownsdale
Coland
Sargeant
Skyberg
Lilah
Kasson
Marshan
Dickinson
Readlyn
Ostrander
Kenyon
Spillville
Tripoli
Vlasaty
Ankeny
Kalmarville
Sawmill
Floyd
Waukee
Lawler
Dowagiac
Shandep
Palms
Oran
Kensett
Nordness
Protivin
Riceville
Schley
Billett
Clyde
Racine
Water
Data Sources:
2008 Areal Photography (LMIC WMS server)
NRCS, Soil Survey Geographic (SSURGO) Database
Map Document: (Y:\Cedar_River\106282\map_docs\mxd\Dobbins_Creek_soils.mxd) 11/19/2009 -- 10:43:02 AM



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Flow and Sediment Data

Flow Data

Stream flow data are available from gauging DNR 48005001 (Dobbins Creek at Austin County Road 61) located 1.7 miles upstream of the confluence with Cedar River (Figure 7) (CRWD, 2008). Flow data are available from 1998 to present at 15 minute intervals based on a stage-discharge relationship. A graph of the available data is provided in a later section.

Sediment/Total Suspended Solids Data

Total Suspended Solids (TSS) data records are available for Dobbins Creek watershed and surrounding area from the following locations (Figure 7):

- Dobbins Creek at 12th Street SE in the city of Austin, MN (Downstream of East Side Lake) – 2000-1.
- Dobbins Creek in the J.C. Hormel Nature Center (upstream of East Side Lake) – 2000-1, 2005 – 6, and 2008 – 9.
- East Side Lake in Austin, MN – 1981, 1989-1993 and 1994-1997.

Culverts

For this project, CRWD provided culvert data as a GIS layer file with points indicating the culvert locations and sizes. The culvert data are from the Upper Cedar River Surface Water Management Plan (WMP). The goal of that plan was to provide flood protection throughout the entire area, Dobbins Creek included, by reducing the 100-year peak flow by 20 percent (BARR Engineering Company, 2007).

Data Assessment for Modeling

As described above, various forms of data are available for land use, soils, topography, climate, land management, stream flow, water quality and infrastructure. Stream flow and sediment data are the most limited for model construction. Stream flow data were reviewed for the station DNR 48005001 since it is in the watershed and within the project boundary. Although flow data are available from 1998 through the present for station DNR 48005001, DNR quality codes for the dataset were: 32 indicating poor quality for period of 1998 through 2005 and some of 2007, 31 indicating fair quality for parts of 2007 and 2008 and 30 indicating good quality for 2008 and 2009 (Peterson, 2009). Data from 2008 and 2009 were used to calibrate the model. Sediment data were available from July and August 2000; May, June, July and August 2001; August, September, October, November 2008 and March and April 2009. Data used for sediment calibration were from July and August 2000; July and August 2001 data were used to validate the model.

Application of the SWAT Model to the Dobbins Creek watershed includes recognition and understanding of data issues and limitations. These constraints result in datasets that are generally limited both spatially and temporally. Where there are data gaps, model defaults were used to support the modeling effort, where necessary. These defaults were based on researched values in the

SWAT model, SWAT manuals and/or conclusions of literature research, and modeling experience. Although there are data gaps within the compiled data, the key to making the most successful use of a SWAT model for the Dobbins Creek watershed is to calibrate the model to observed flow and sediment data.

Model Construction

The following describes the steps to apply the SWAT model to Dobbins Creek watershed. The process is divided into three key areas; watershed, land use, and soils.

The watershed delineation was completed by loading the previously described DEM into SWAT. SWAT uses the DEM to delineate the stream location and subbasin boundaries. The delineated subbasin boundaries from the WMP were used as a guide for delineating the subbasins within SWAT (BARR Engineering Company, 2007). Thirty-seven (37) basins (Figure 8) and the outlet to the Cedar River were defined. Because of the difference in focus and the streams delineated from the DEM, some of the smaller subwatersheds from the WMP report were aggregated into larger subwatersheds during the SWAT processes reducing the total number from 59 to 37 subwatersheds (BARR Engineering Company, 2007).

The land use and soil themes were defined by loading the NLCD land use and SSURGO soil data layers. SWAT uses the land use data to determine water and nutrient runoff and infiltration capacity. Land Use/Land Cover data were then expressed in SWAT codes as shown in Table 4.

The soils data were from the SSURGO database, which included the type of soil, their infiltration capacity, water retention capacity, and other soil characteristics. These data assisted in simulating runoff, sediment transport and vegetation potential (for crop growth simulation) in SWAT. The land use, soil and slope (derived from the DEM) data were reclassified using the SWAT land cover classes, the state soil identifiers and the calculated land slopes and then superimposed in SWAT. This resulted in each watershed having subbasin of specific land use, soils and slope (e.g. corn/Oran/0-0.5%).

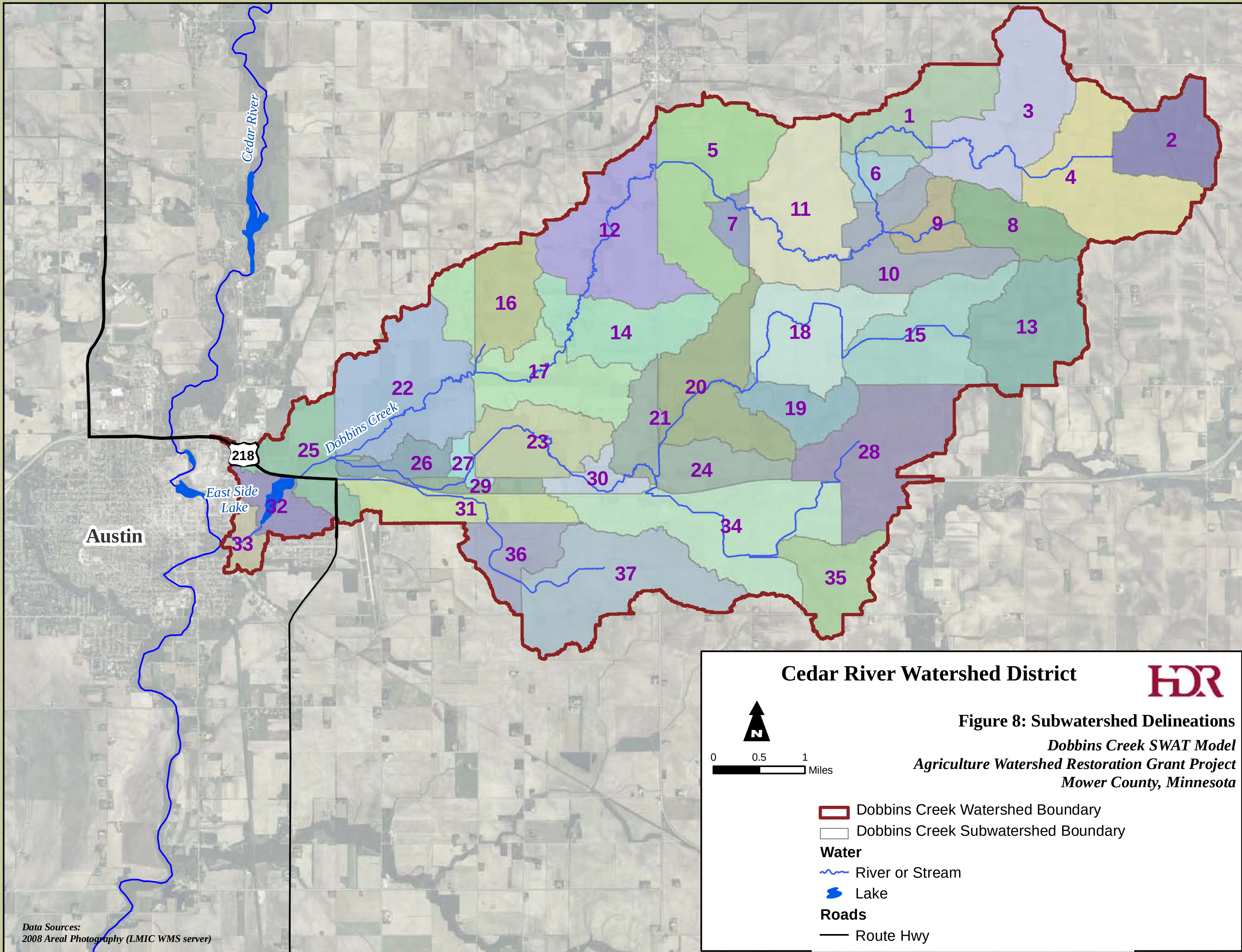
With the characteristics of each subbasin defined, the hydrologic response unit (HRU) distribution was selected. HRUs were defined using the default 'land use percentage over subbasin area' of 10 percent and 'soil class percentage over land use area' of 10 percent and 'slope class percentage over the land use area' of 10 percent. This resulted in 826 HRUs. For each HRU, water flux and transport of sediment and nutrients are simulated in the SWAT model and then routed through a subwatershed, i.e., water and chemicals are transported from one subwatershed to the next, depending on flow characteristics.

After the HRUs were developed, the land management practices data were incorporated into the model. Model defaults were used except for agricultural areas where additional land management practices were specified. For the agricultural areas, the crop rotations shown in Table 1 were used (Cedar River Watershed District, 2008). Corn was the only crop where both tillage and fertilizer practices occurred. Those practices were put in the model based on data received from the CRWD (Table 5).

After inputting watershed land use, soils, slope and land management information were completed, the SWAT View was used to enter weather data and to define the coefficients. Climate data from station NOAA 210355 – Austin 3S, along with the model databases and simulation equations, were used for the climatological data. The internal SWAT weather simulation generator (based on regional weather station data) was used for other climate parameters (e.g., solar radiation and wind speed). Default coefficients were used for the initial model simulation.

Table 4. Dobbins Creek NLCD and SWAT Codes

Land Use (NLCD, 2001)	Land Use (SWAT code)
Agricultural Land - CCSB	CCSB
Agricultural Land - Corn	CORN
Agricultural Land - CSBC	CSBC
Agricultural Land - CSBS	CSBS
Agricultural Land - SBCC	SBCC
Agricultural Land - SBCS	SBCS
Agricultural Land - SBSC	SBSC
Agricultural Land - Soybeans	SOYB
Forest – Deciduous	FRSD
Forest – Evergreen	FRSE
Hay	HAY
Pasture	PAST
Range – Grasses	RNGE
Residential – High Density	URHD
Residential – Low Density	URLD
Residential – Medium Density	URMD
Water	WATR
Wetland – Forested	WETF
Wetland – Non Forested	WETL


Cedar River Watershed District
Figure 8: Subwatershed Delineations
Dobbins Creek SWAT Model
Agriculture Watershed Restoration Grant Project
Mower County, Minnesota
0
0.5
1
Miles
Dobbins Creek Watershed Boundary
Dobbins Creek Subwatershed Boundary
Water
River or Stream
Lake
Roads
Route Hwy
Cedar River
Dobbins Creek
East Side Lake
Austin
218
1
2
3
4
5
6
7
8
9
10
11
12
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34
35
36
37
Data Sources:
2008 Areal Photography (LMIC WMS server)

Table 5. Dobbins Creek SWAT Corn Crop Management Input

Operation	Quantity	SWAT Model Schedule (Date)
Tillage – Chisel Plow		April 27
Fertilizer		May 5
Anhydrous Ammonia	84.1kg/ha	
Urea	4.5 kg/ha	
DAP	33.6 kg/ha	
Pot Ash	35.9 kg/ha	
Manure - Dairy	83.8 kg/ha	
Manure – Beef	400.6 kg/ha	
Manure - Swine	6,102 kg/ha	
Manure - Horse	39.4 kg/ha	
Manure - Sheep	325.1 kg/ha	
Manure - Duck	34.3 kg/ha	
Plant		May 16
Fertilizer - Starter	5.0 kg/ha	May 19
Harvest and Kill		October 15
Tillage – Chisel Plow		November 15
Fertilizer - DAP	11.2 kg/ha	November 15

Model Performance

The model results were compared to observed data to determine whether the model simulations provided a reasonable representation of actual conditions. Standard SWAT calibration practices were followed for stream flow and sediment calibration and validation. A portion of the available flow and sediment dataset were reserved and used to validate the model. The remaining data were used for the SWAT sensitivity analysis and calibration procedure.

The calibration process is an iterative process of adjusting parameters specific to flow and sediment and checking the results against known observed values. SWAT comes equipped with functions that allow us to perform sensitive analysis and auto-calibration on un-calibrated models. For this project, only the sensitive analysis was used and the model was manually calibrated. To perform the sensitivity analysis, SWAT uses the Latin Hypercube Sampling (LHS) and the One factor At a Time (OAT) design to form the LHS-OAT method (Srinivasan, 2008). The model divides the parameter (s) spaces in N parts of equal probability 1/N, then takes N samples according to LHS scheme and sequentially determines the OAT sensitivity for each LHS point (Srinivasan, 2008).

Using this method affords the ability to determine the sensitivity each parameter selected has on changing the results of the model. For instance, if there are six (6) parameters that could effect change, an endless amount of time and money could be spent adjusting each parameter to calibrate the model. The sensitive analysis checks each one of the six (6) parameters by comparing the un-calibrated model to the observed results to see how those values would affect the output of the model. They results of the sensitive analysis could be presented as shown in Table 6. Table 6 shows that three (3) parameters (A, B, and C) are the most sensitive, while D – J are insensitive parameters under any spatial or temporary condition.

Table 6: Example SWAT Sensitivity Analysis Output

Parameter	Rank
A	1
B	2
C	3
D	7
E	7
F	7

The Dobbins Creek model was calibrated to flow and sediment, in that order. The model was calibrated to data from DNR 48005001 and the J.C. Hormel Nature Center for flow and sediment, respectively. Figure 7 shows monitoring station locations in relation to the s boundaries. The confluence of Cedar River and Dobbins Creek is approximately 2 miles downstream of the monitoring point, located at the outlet of subwatershed 22 (Figure 8). In the following sections, the process of calibrating the model to flow and sediment are described.

Calibration and Validation

Flow

At the start of the project, the available flow dataset from the DNR was examined. It was determined, based on data quality notes that accompanied the dataset, that only data from 2008 (April, May, June, July, August, September, October, and November) and 2009(April) were of sufficient quality to use (Peterson, 2009). Average daily flow calculated was 38 cfs, with the highest flow recorded on June 9, 2008 and lowest flow recorded on September 21, 2008 of 928 cfs and 2 cfs, respectively. The data were divided as noted below for calibration and validation which were both evaluated and checked on a monthly and daily timestep, respectively. Again, the validation data were removed (reserved) and only the data from the months noted below were used to calibrate the model.

Calibration	Validation
April 08	May 08
June 08	July 08
August 08	September 08
October 08	November 08
April 09	

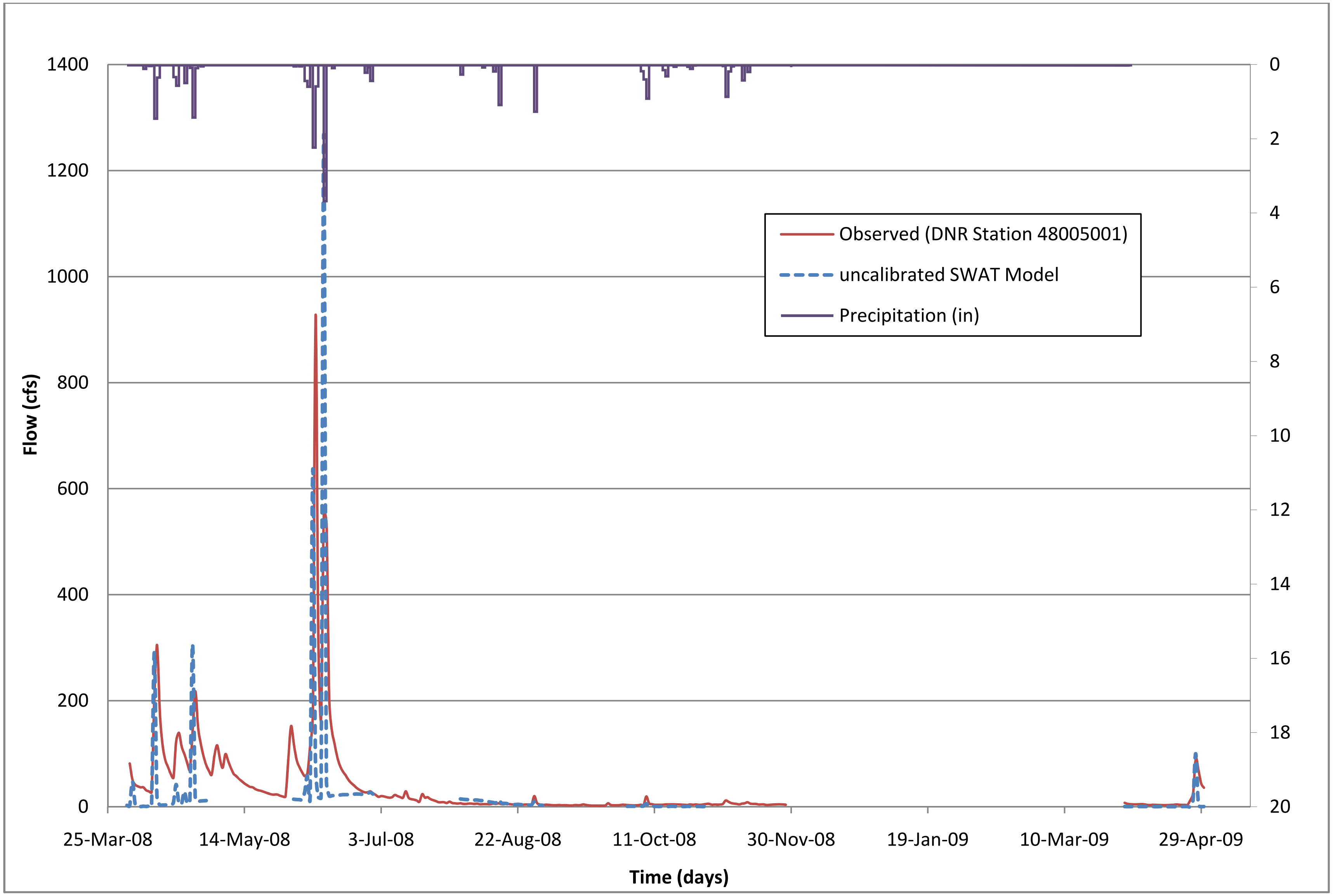
The output of the un-calibrated model to observed data are shown on Figure 9. Figure 9 illustrates that the un-calibrated model is under-predicting the total volume of runoff. However, the un-calibrated model simulated the peak magnitude and timing of the runoff hydrographs within an acceptable range. The available flow calibration parameters were reviewed and 17 parameters, specific to managing runoff and base flow, were selected for potential calibration adjustment. Using the selected 17 parameters, the SWAT sensitivity analysis was run to determine which parameters were the most or least sensitive.

The sensitivity analysis showed CN2 (Curve Number) was the most sensitive; Sftmp (Snowfall Temperature), Smfmn (Minimum Snowmelt Temperature) and Smfmx (Maximum Snowmelt Temperature) were the least sensitive/ insensitive to change, (Table 7).

Table 7. Dobbins Creek SWAT Model Sensitivity Analysis Results-Flow

Parameter	Summary	Rank
CN2	Initial SCS runoff curve number for moisture condition II.	1
ESCO	Soil evaporation compensation factor.	2
TIMP	Snow pack temperature lag factor.	3
SOL_AWC	Available water capacity of the soil layer (mm H_2O/mm soil).	4
REVAPMIN	Threshold depth of water in the shallow aquifer for revap or percolation to the deep aquifer to occur (mm H_2O).	5
ALPHA_BF	Base flow alpha factor (days).	6
GWQMN	Threshold depth of water on the shallow aquifer required for return flow to occur (mm H_2O).	7
CH_K2	Effective hydraulic conductivity in main channel alluvium (mm/hr).	8
SURLAG	Surface runoff lag coefficient.	9
SMTMP	Snowmelt temperature (°C)	10
CH_N	Manning's 'n' value for the tributary channel	11
GW_REVAP	Groundwater revap coefficient. As GW_REVAP approaches 0, movement of water from the shallow aquifer to the root zone is restricted.	12
SLOPE	Land slope (m/m)	13
SLSUBBSN	Average slope length (m).	14
SFTMP	Snowfall temperature (°C)	18
SMFMN	Melt factor for snow on December 21 (mm H_2O/°C-day).	18
SMFMX	Melt factor for snow on June 21 (mm H_2O/°C-day).	18

Figure 9. Dobbins Creek Observed Vs. Un-calibrated SWAT Daily Model



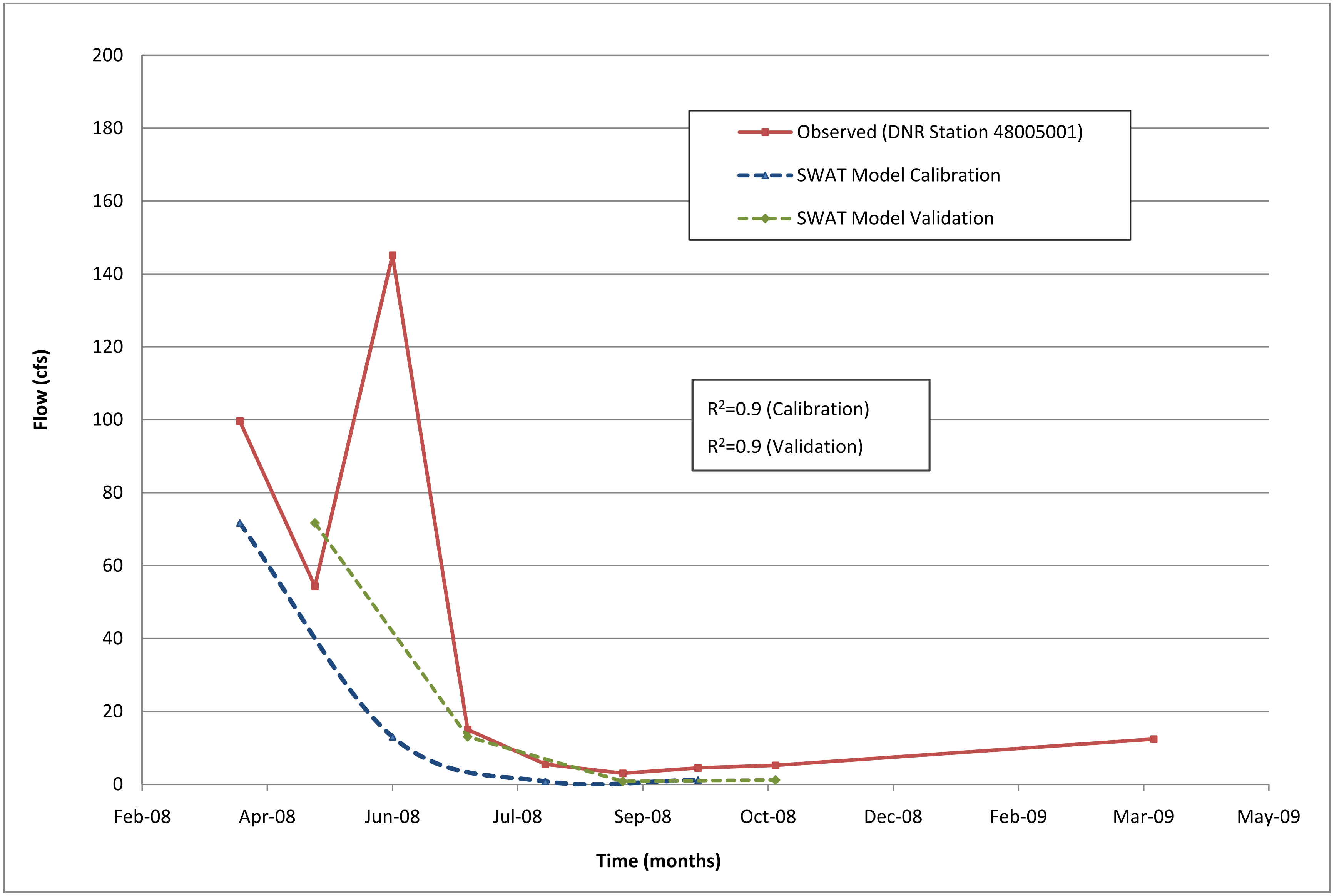
The sensitivity analysis provided a starting point for manually. Of the 17 parameters tested and ranked, the top ranked parameters were used to manually calibrate the model. After an iterative process, 12 of those parameters were adjusted to produce a flow-calibrated SWAT model of the Dobbins Creek Watershed (Table 8Figure 7).

The model was considered calibrated when the R^2 of the observed to the modeled data was 0.7 or greater for monthly flow values for the calibration period. The model was first calibrated to the monthly average flow value and then checked against daily average flow value. The calibrated flow model was predicting, at R^2, 0.9 and 0.7 for average monthly and average daily flows, respectively (see Figure 10 and Figure 11). For the validation period, the model was predicting, at R^2 of 0.9 and 0.7 for average monthly and average daily flows, respectively. Given that the model met, and in some cases exceeded, the acceptable R^2 of 0.7 or greater, the model was considered calibrated for flow.

Table 8. Dobbins Creek SWAT Model Calibration Parameters - Flow

Parameter	Units	Lower Bound	Upper Bound	Default	Calibrated Model
ALPHA_BF	days	0	1	0.048	0.7
CH_K2	mm/hr	0	25	0	12
CH_N		0.014	.024	0.014	0.019
CN2		-0.05	0.05	Varies	.05
ESCO		0	1	0	1
GW_DELAY	Days	0	31	31	16
GWQMN	mm	0	5,000	0	1457.17
REVAPMIN	Mm	-100	100	1	8.26
SMTMP	°C	-0.25	.25	1	-0.12
SOL_AWC	m/m	-0.25	.25	Varies	0.19
SURLAG		0	10	4	0.5
TIMP		0	1	1	0.68

Figure 10. Dobbins Creek Observed Vs. SWAT Model - Average Monthly Flows



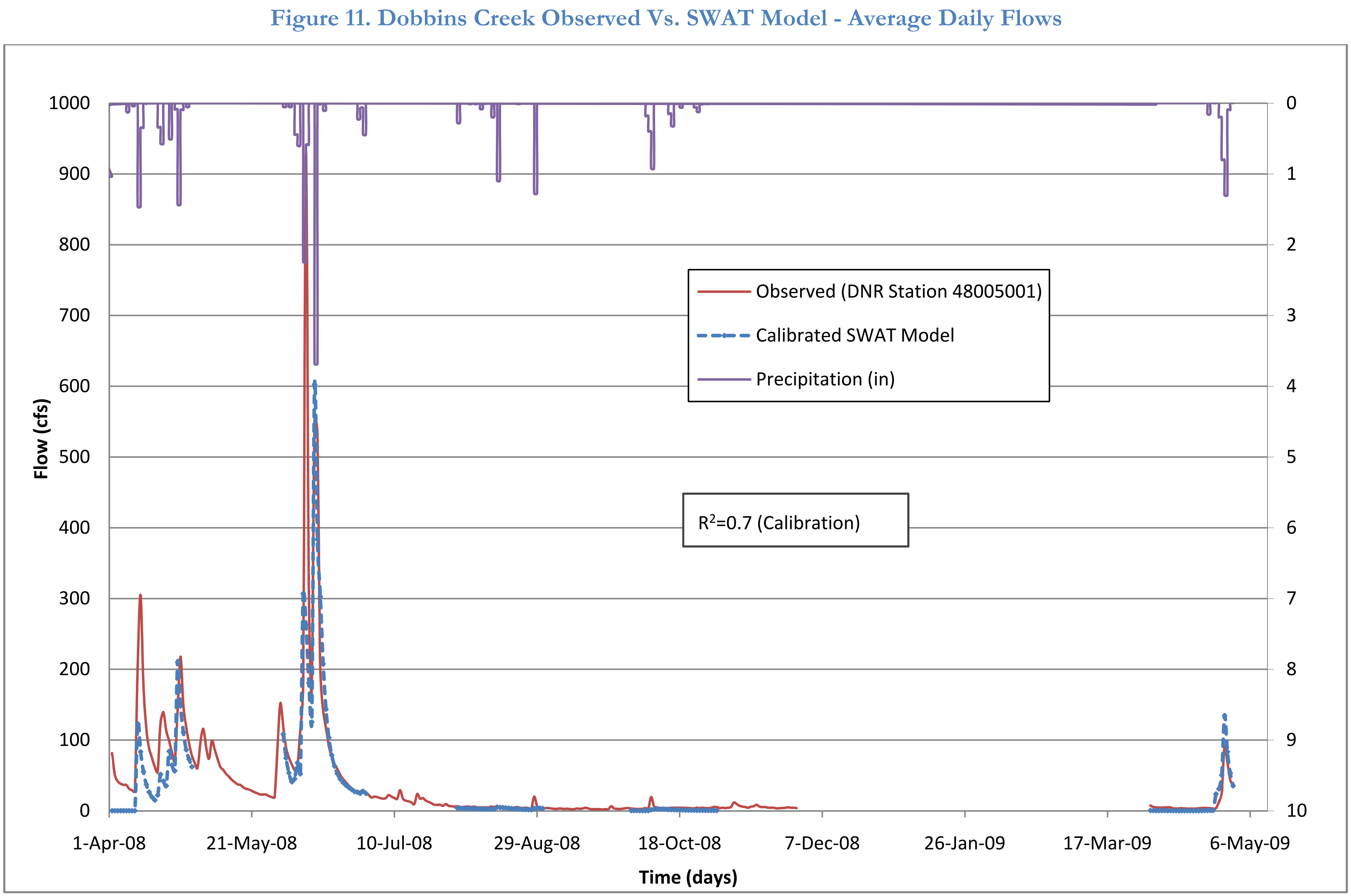


Figure 11. Dobbins Creek Observed Vs. SWAT Model - Average Daily Flows
1000
900
800
700
600
500
400
300
200
100
0
Flow (cfs)
0
1
2
3
4
5
6
7
8
9
10
Observed (DNR Station 48005001)
Calibrated SWAT Model
Precipitation (in)
R²=0.7 (Calibration)
1-Apr-08
21-May-08
10-Jul-08
29-Aug-08
18-Oct-08
7-Dec-08
26-Jan-09
17-Mar-09
6-May-09
Time (days)

Figure 12

Total Suspended Solids

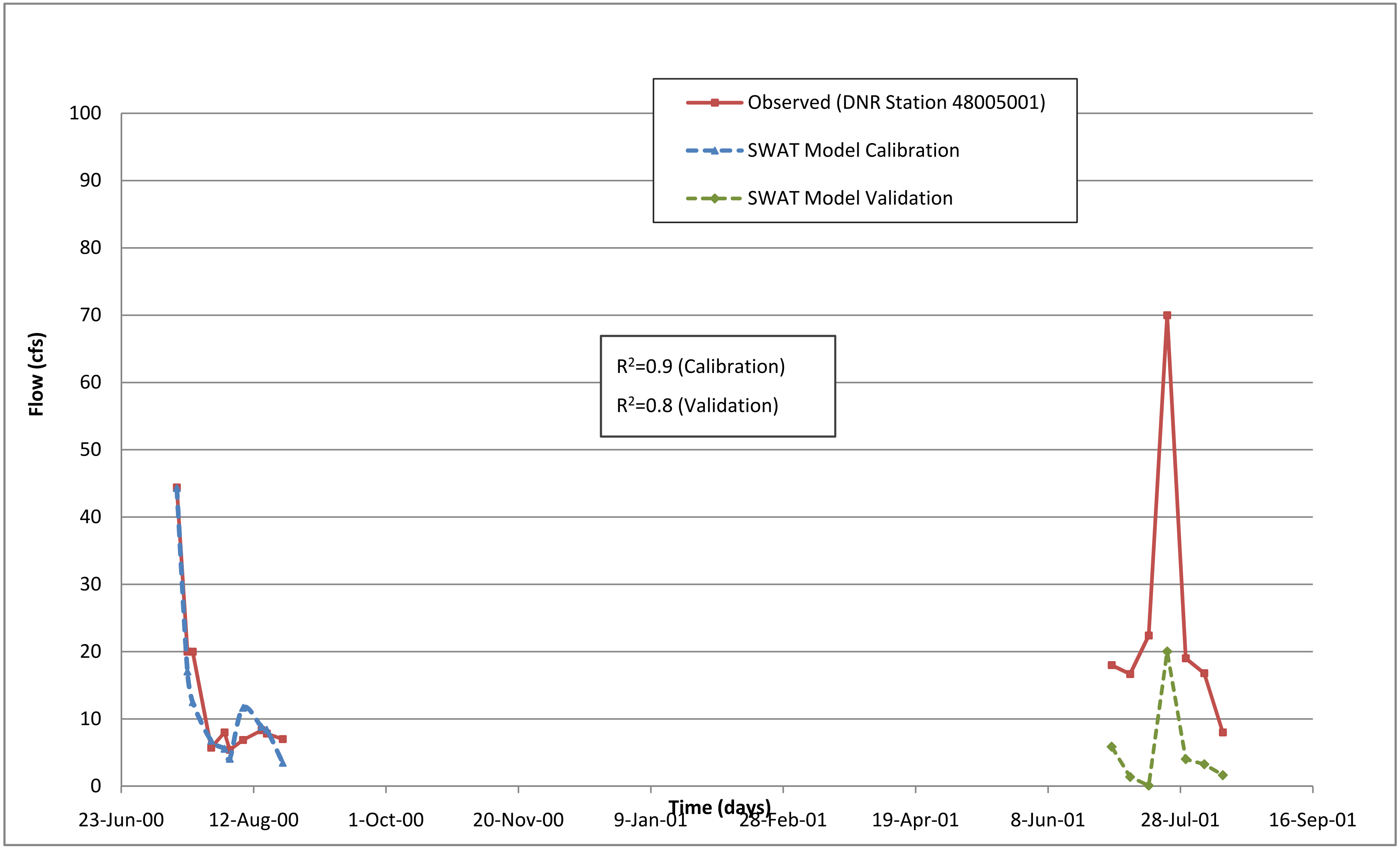
The same process used to calibrate the model to flow was used to calibrate the model to observed daily TSS data. The model was calibrated to TSS data from July and August of 2000 and validated using the July and August 2001 data. Figure 12 shows the observed data to the un-calibrated model prediction.

First, a SWAT sensitivity analysis was performed and then the internal auto-calibration function with a reduced number of parameters was employed. There were six initial parameters that were ranked for TSS, as presented in Table 9. As a result of researching land use practices and evaluating soils conditions in the watershed, the only parameter changed was SPEXP. It was changed from the default value of one (1) to two (2). The model was considered calibrated to TSS when the R^2 for calibration was 0.9 and the R^2 for validation was 0.8 (Figure 12) for available daily TSS values. At the conclusion of this process, a SWAT model calibrated to both flow and TSS for the Dobbins Creek watershed was produced.

Table 9. Dobbins Creek SWAT Model Sensitivity Analysis Results - Sediment

Parameter	Summary	Ranking
USLE_P	USLE equation support practice factor	1
SPCON	Linear parameter for calculating the maximum amount of sediment that can be re-entrained during channel sediment routing	2
USLE_C	Minimum value of USLE C factor for water erosion applicable to the land cover/plant	3
SPEXP	Exponent parameter for calculating sediment re-entrained in channel sediment routing	4
CH_COV	Channel cover factor	7
CH_EROD	Channel erodibility factor	7

Figure 12. Dobbins Creek Observed Vs. SWAT Model – Average Daily TSS Concentrations



Evaluation of Load Reduction

Using the Dobbins Creek calibrated SWAT model for flow and sediment, five broad scenarios were evaluated to determine their ability to reduce peak flows and sediment transported through the Dobbins Creek system. The primary focus of this project is sediment reduction given the turbidity assessment; however, best management practices selected for implementation in two of the scenarios also consider reducing peak flow. The five general scenarios are:

1. Scenario A - Existing Condition
2. Scenario B - Temporary Distributed Storage
3. Scenario C - Perennial Vegetation
4. Scenario D - Erosion Control
5. Scenario E - Combination

The goal of these scenarios, as documented by CRWD, is to meet applicable state surface water quality standards. Dobbins Creek is a class 2B stream with a turbidity limit of 25 NTUs which translated to between 30 – 40 mg/l of TSS (*Personal Communication with Bill Thompson, MPCA*).

The three branches of Dobbins Creek, North, South and Unnamed, were examined using the calibrated model to determine if those reaches are meeting current water quality standards based on monthly averages of TSS concentrations. As illustrated in Figure 13, the south branch consistently meets water quality standards. While the Unnamed Branch, violates the standard by about 5 mg/l one month over the 10-year period. On the other hand, North Branch violates the water quality standard five times over the 10-year period with exceedance of the standard ranging from about 7 mg/l to 35 mg/l. As a result, the focus of BMP implementation will be around the North Branch of Dobbins Creek.

Using the calibrated Dobbins Creek SWAT model, BMPs were selected and evaluated for scenarios B, C, and D based on their ability to get the stream branches to meet TSS water quality standard. In addition, Scenario B considered peak flow reduction. Scenario E, on the other hand, represented a combination of practical and feasible practices, taking into account improving water quality, reducing peak flows and optimizing capital investments. The scenarios presented here support the TSS assessment for the Dobbins Creek watershed. TSS reductions in the Dobbins Creek watershed should improve water quality conditions downstream; however, assessment of TSS, nutrient cycling and water quality issues in East Side Lake and downstream to the Cedar River are beyond the scope of this study.

The overall performance of best practices used in each of the scenarios was assessed using available climate data for the 1999-2008 (10-year) period (Figure 14). For that period, annual median and average rainfalls were 35.8 (2005) and 35.2 inches, respectively. Relatively wet and dry annual rainfalls were seen in 2004 (42.6 inches) and 2003(27.8 inches), respectively. Over that period of record, air temperature readings were 34.4°C (94°F), -28.9°C (-20°F) and 7.2°C (45°F) which represent, maximum, minimum and average readings, respectively. The scenarios are described below.

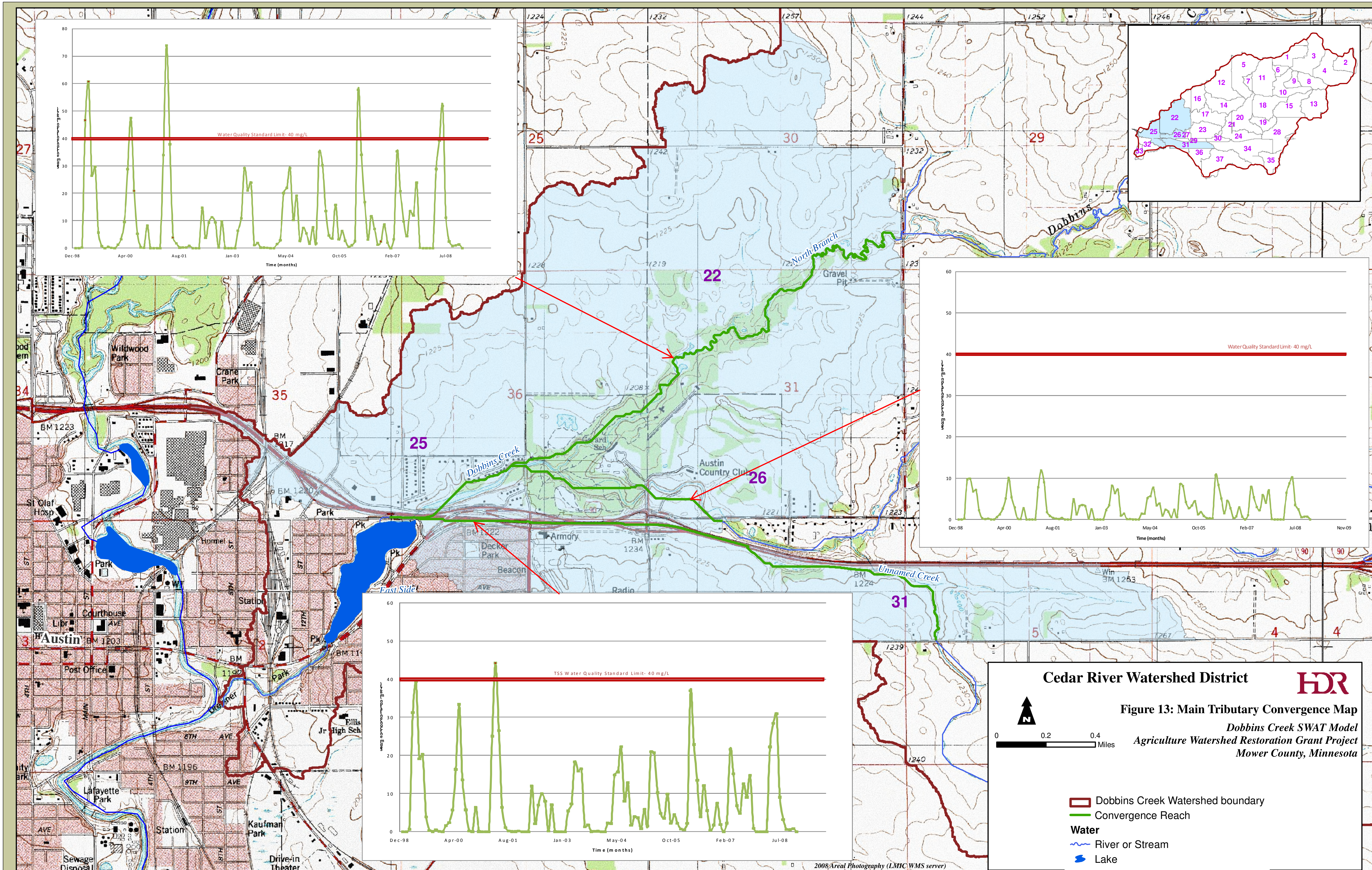


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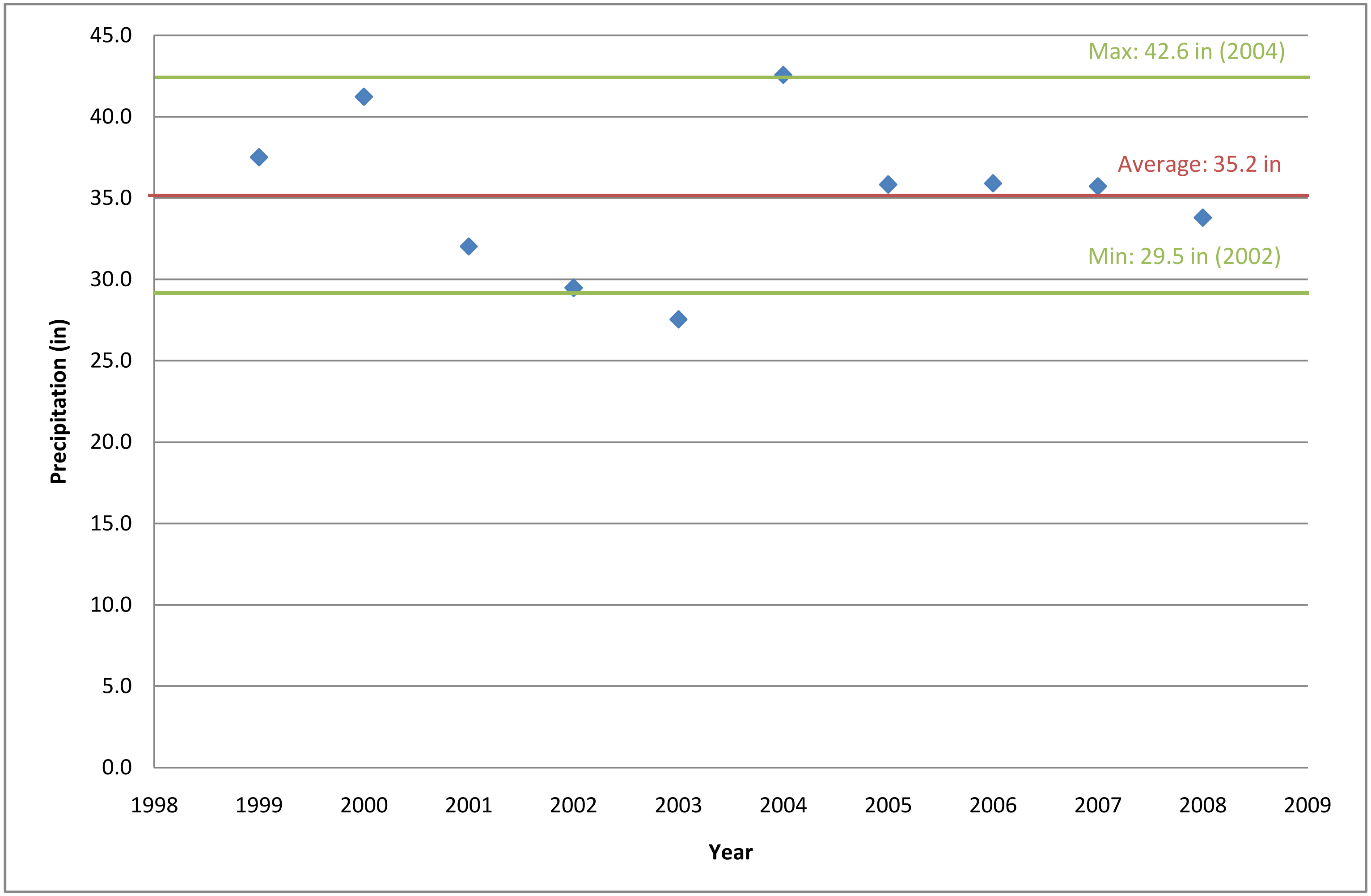
Figure 14: Annual Precipitation for the Dobbins Creek Watershed (1999 - 2008)



Scenario A - Existing Condition

Description

This scenario calls for CRWD, residents and stakeholders to maintaining existing practices as documented in previous sections. This scenario identifies no improvement to infrastructure, farming practices or the main/tributary channels.

Computed Water Quality Benefits

The Existing Condition scenario provides no water quality benefits. As previously noted, over 10-year period (1999 – 2008) North Branch and the Unnamed Branch do not meet water quality standard. Doing nothing could further degrade Dobbins Creek, and lead to additional impairments and/or more of the tributaries being impaired. Figure 15, Figure 16, and Figure 17 presents the baseline for which the other scenarios will be compared.

Estimated Cost

Since this scenario does not require any changes, the estimated cost of implementation is $0.00. However, there could be adverse impacts to other valued amenities, in both direct and indirect costs, if the water quality is not improved.

Implementation Challenges

Under section 303 (d) of the Clean Water Act (CWA), all states are required to address impaired waters that are polluted or degraded to meet their respective water quality standards. In this case, TSS water quality standards would not be met. Doing nothing would be a direct violation of Minnesota Statute 7050.

Figure 15: Dobbins Creek - Scenario A: Existing Condition Monthly Average Peak Flow Graph (1999 – 2008)

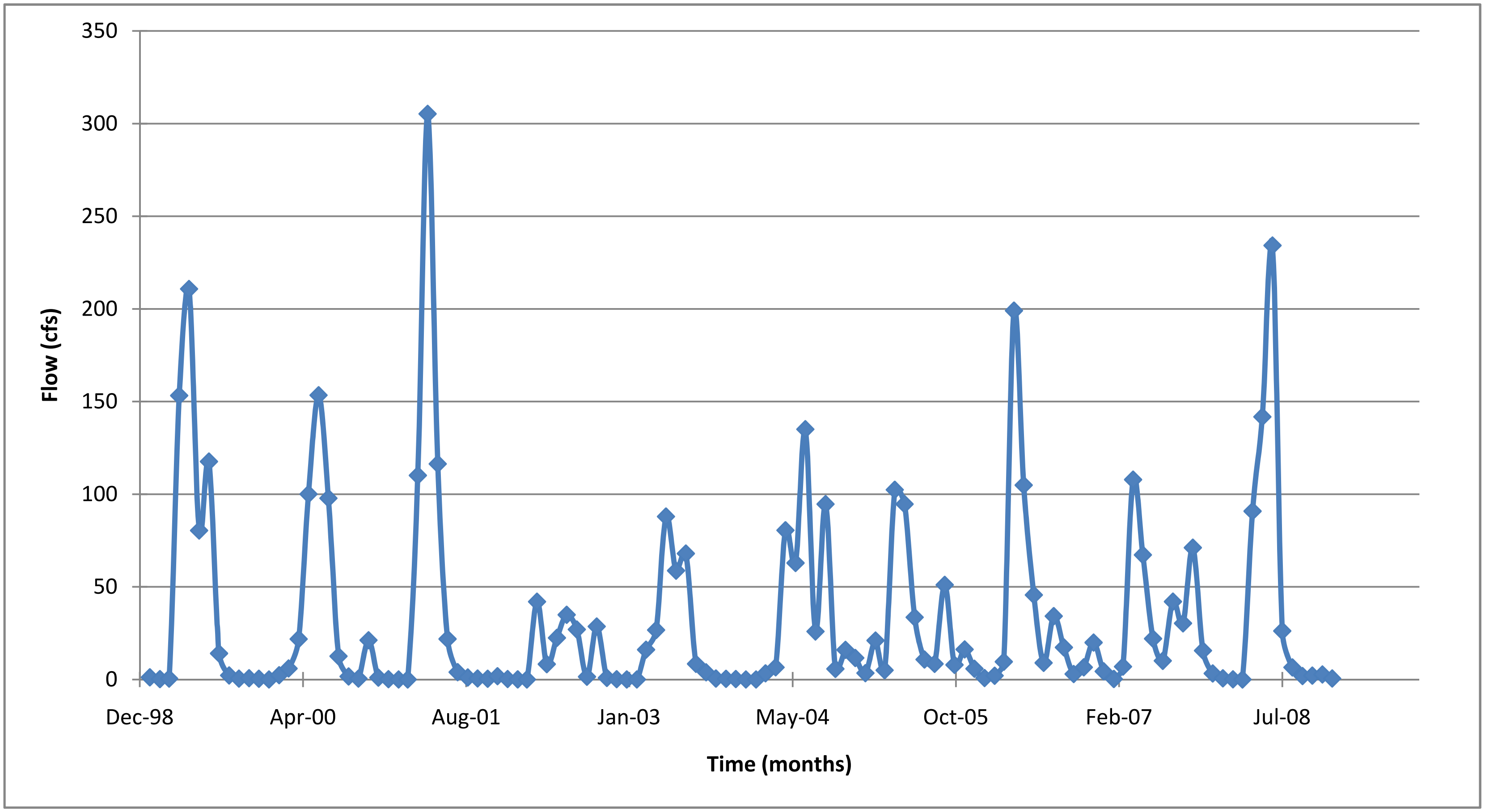


Figure 16: Dobbins Creek - Scenario A: Existing Condition Monthly Surface Runoff Graph (1999 – 2008)

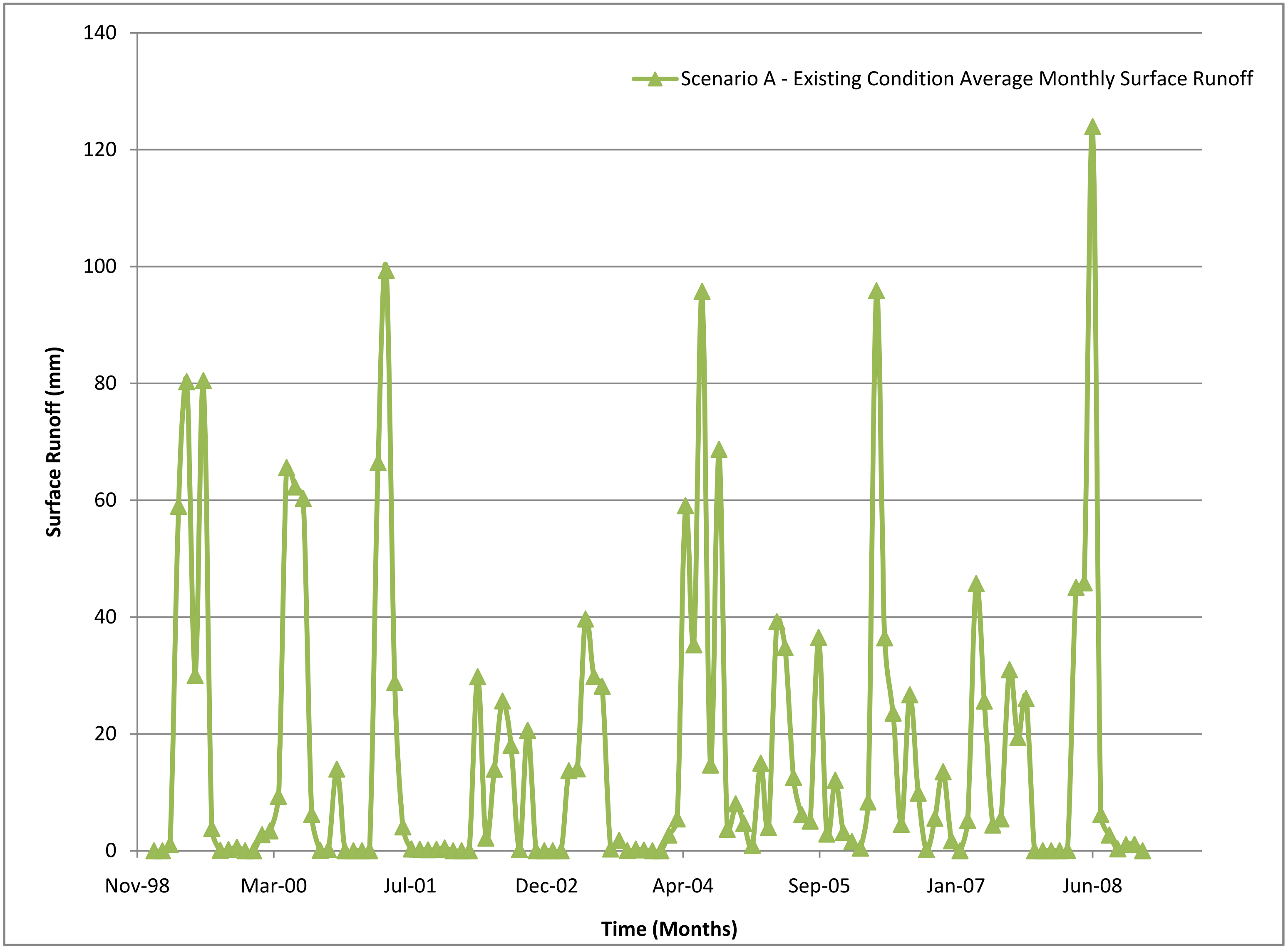
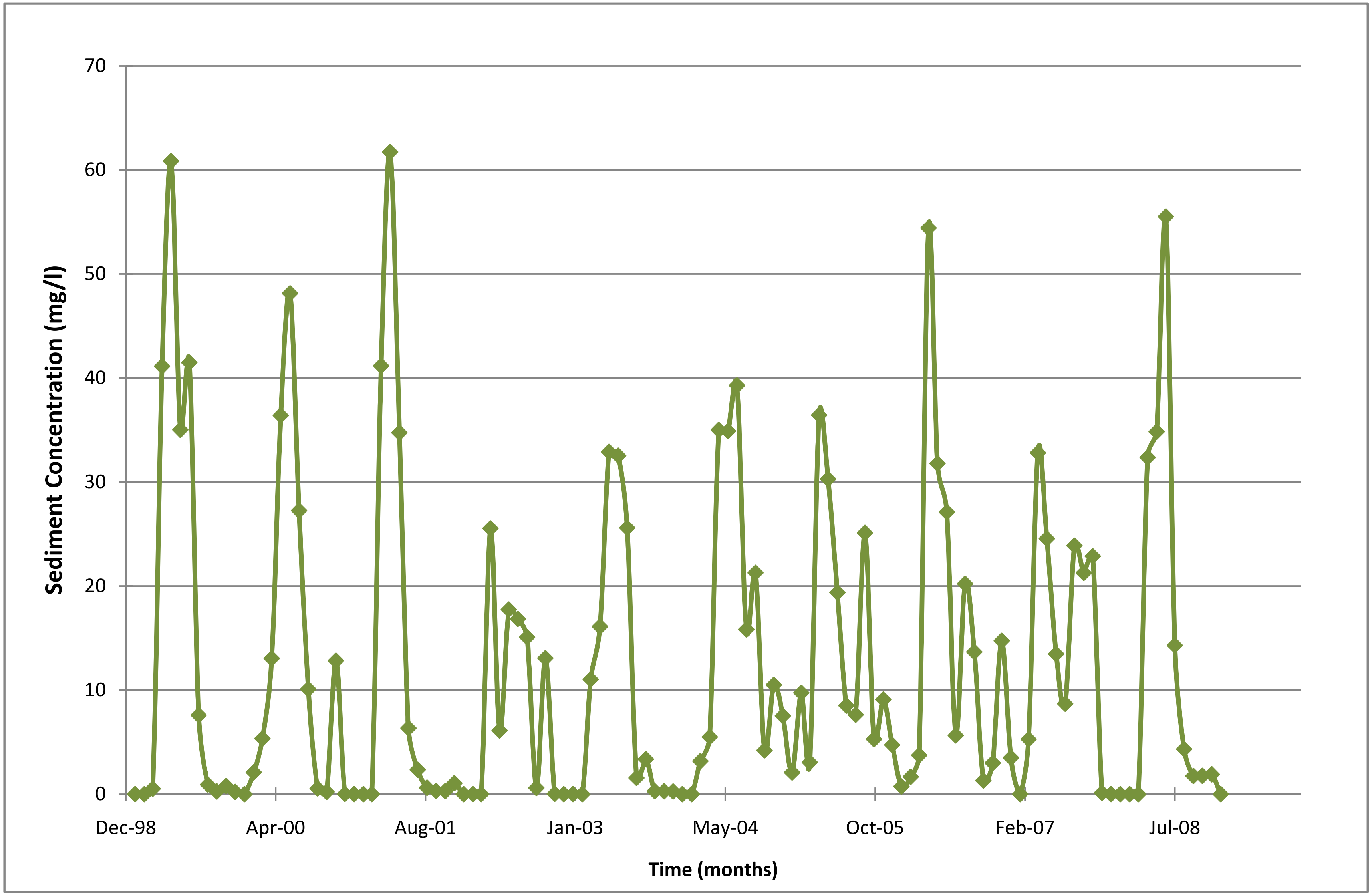


Figure 17: Dobbins Creek - Scenario A: Existing Condition Monthly Average TSS Concentration Graph (1999 – 2008)



Scenario B – Distributed Temporary Storage

Description

The CRWD identified three different storage options: wetland restoration sites, flood reduction sites and temporary storage areas (Figure 18). The wetland restoration sites have not been formally studied, however, initial discussion have taken place between CRWD and property owners. Formal studies commissioned by CRWD and other stakeholders on the flood reduction sites and temporary storage site are described below.

In September 2009, CRWD commissioned two Flood Reduction Feasibility Studies (Jones,Haugh & Smith Inc - Site 1, 2009) (Jones, Haugh & Smith Inc - Site 2, 2009). The draft reports identified two location Site 1 (Sections 7 and 18 – Dexter Township) and Site 2 (Section 28–Red Rock Township) which could be used for flood reduction sites during high flow events (Figure 16). Site 1's watershed is approximately 660 acres, which is about 60 percent of subbasin 3 and has a potential storage volume of 25 ac-ft. Site 2's watershed is approximately 280 acres, which is about 30 percent of subbasin 17 with a potential storage volume of 13 ac-ft. Those storage areas were considered in SWAT to determine their water quality benefits.

In September 2007, the Upper Cedar River Ad Hoc Committee commissioned the Upper Cedar River Surface Water Management Plan (WMP). The primary focus of the WMP was to provide flood protection and reduce the 100-year peak flows by 20 percent. The WMP documents surface areas and temporary storage volumes adjacent to culverts in the Upper Cedar River Watershed, of which Dobbins Creek is a part. Using findings of that report as a foundation, temporary storage sites' surface areas and storage volumes were identified throughout the watershed as documented in Table 10. Because North Branch and to a lesser extend Unnamed Branch were the focus of these scenarios, temporary storage sites were located in those subwatersheds.

Table 10: Dobbins Creek Temporary Storage Sites Surface Areas and Volumes

WMP Watershed No.		Area of Inundation (ac)	Detention Volume (ac-ft)	Depth of Storage (ft)	SWAT Subbasin	SWAT (ac)	SWAT Storage Depth (ft)	SWAT Detention Volume (ac-ft)
Dbbn	30	114	518.6	4.5	22/26	50	4.5	227.5
Dbbn	31	3.5	5.8	1.7	13	4	1.7	5.8
Dbbn	15	33	118.5	3.6	11	33	3.6	118.5
Dbbn	16	15.4	22.5	1.5	7	15	1.5	22.5
Dbbn	17	15.2	31	2.0	5	15	2.0	31.0
Dbbn	18	73.2	297	4.1	5	50	4.1	202.9
Dbbn	19	18.5	40.1	2.2	12	19	2.2	40.1
Dbbn	20	38.1	140	3.7	12	38	3.7	140.0
Dbbn	21	35.5	112.9	3.2	12	36	3.2	112.9
Dbbn	48	12.5	45.8	3.7	30	13	3.7	45.8
Dbbn	49	60.3	231.8	3.8	34	50	3.8	192.2
Dbbn	50	27	106.4	3.9	37	27	3.9	106.4
Dbbn	51	6.5	23.4	3.6	37	7	3.6	23.4
Dbbn	10	435	189.1	0.4	1	50	0.4	21.7
Dbbn	11	14.6	22.8	1.6	6	15	1.6	22.8
Dbbn	7	10.8	28.4	2.6	3	11	2.6	28.4

The principal goal of this scenario was to reduce the continuous simulated peak flows (for the 10-year period) by 10 percent. Again, the focus of this goal is not to meet the water quality standard but the reduce peak flows by 10 percent.

The mentioned storage options were evaluated in stages, one building off the other. Initially, flood reduction and wetland restoration sites were put into the model and the outputs checked to determine whether the 10 percent peak flow reduction had been met. Recognizing it hadn't been met, the temporary storage areas derived from the WMP was incorporated in phases as noted in Table 11. The first phase focused on the North Branch subwatershed because it did not meet water quality standard more times that any of the other branches. In addition, within the subwatershed, subbasins were ranked based on sediment yield. Subbasins in Phase 1 represented areas that had the high yields per unit area.

Table 11: Dobbins Creek Temporary Storage Phasing Plan

	SWAT Subbasins
Phase 1	3
	1
	6
	11
	7
	5
	12
	22
Phase 2	26
	13
Phase 3	37
Phase 4	30
	34
Phase 5	1
	22
	5

Computed Water Quality Benefits

The result showed a 10 percent reduction in continuous simulated average monthly peak flows from the Existing Condition (Figure 19). There would also some water quality benefits realize. TSS concentrations for the 10-year period based on using the flood reduction, wetland restoration and all phases of temporary storage sites are shown in Figure 16. This scenario generated TSS concentration reduction of 4 – 5 percent during some months and as high as 50 – 70 percent reductions in others. Although, Figure 20 illustrates positive change in TSS concentration as a result of using these storage options, water quality standard were not met.

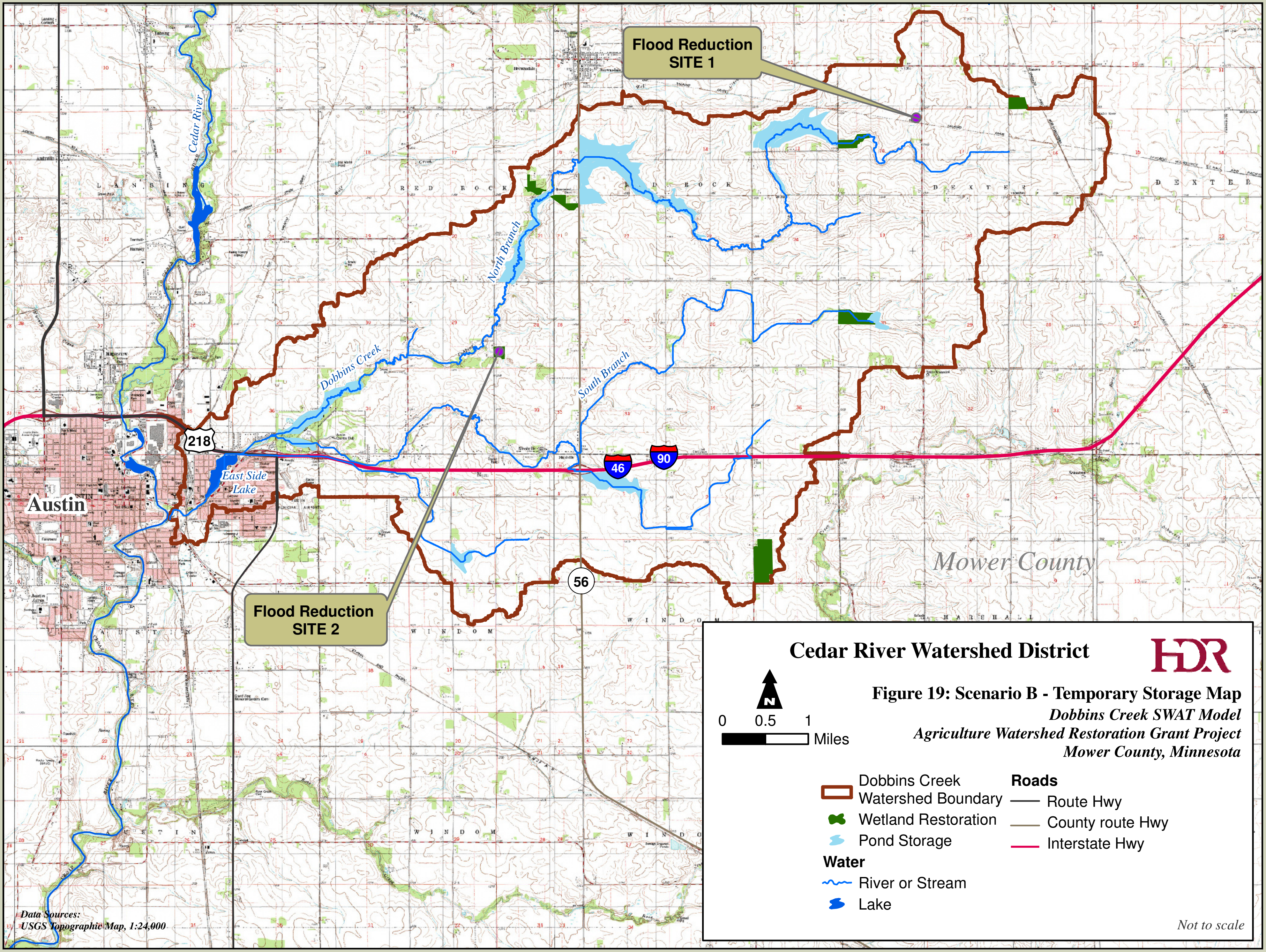


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Figure 19: Dobbins Creek - Scenario B: Temporary Distributed Storage Monthly Average Peak Flow Graph (1999 – 2008)

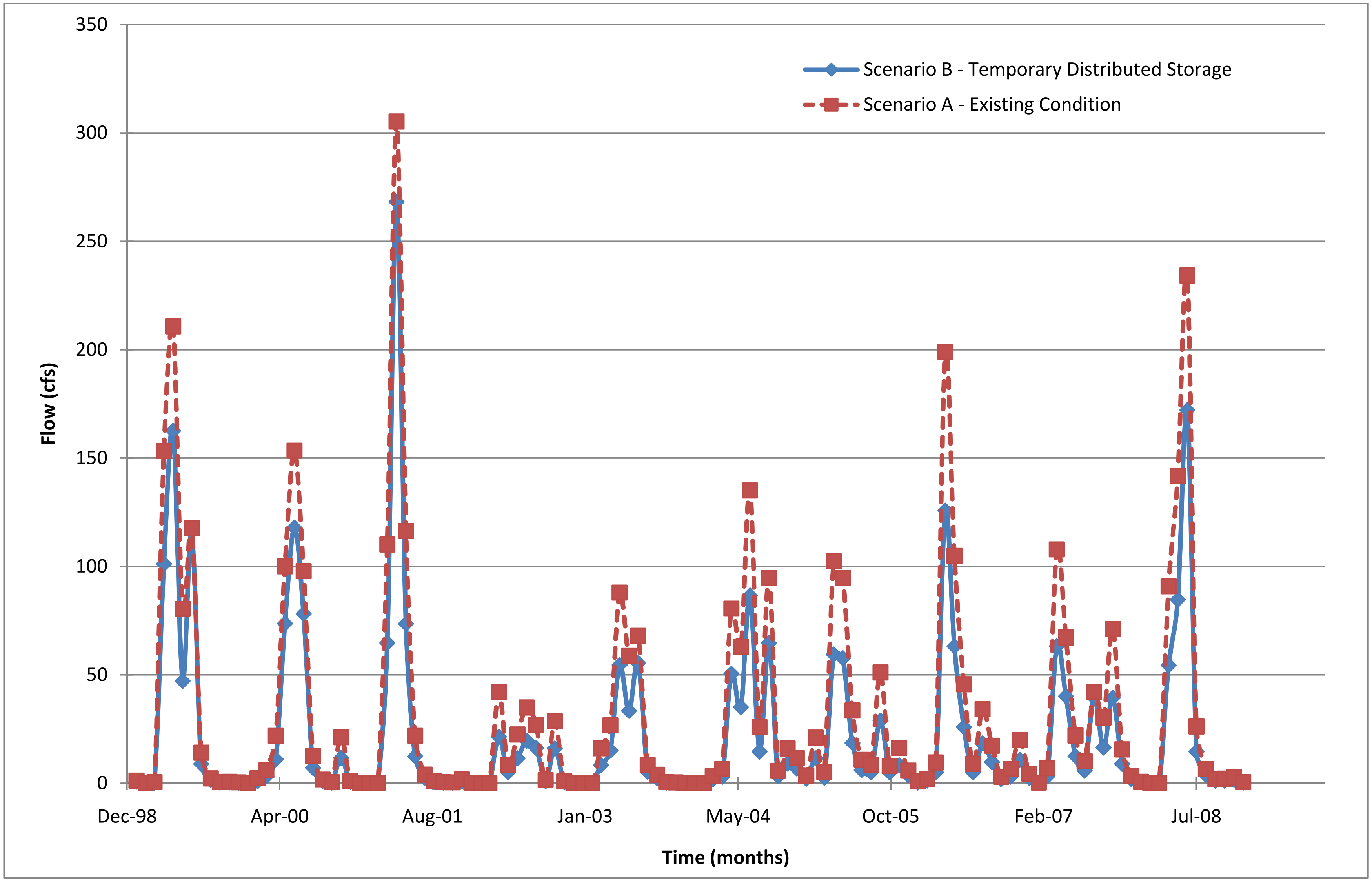
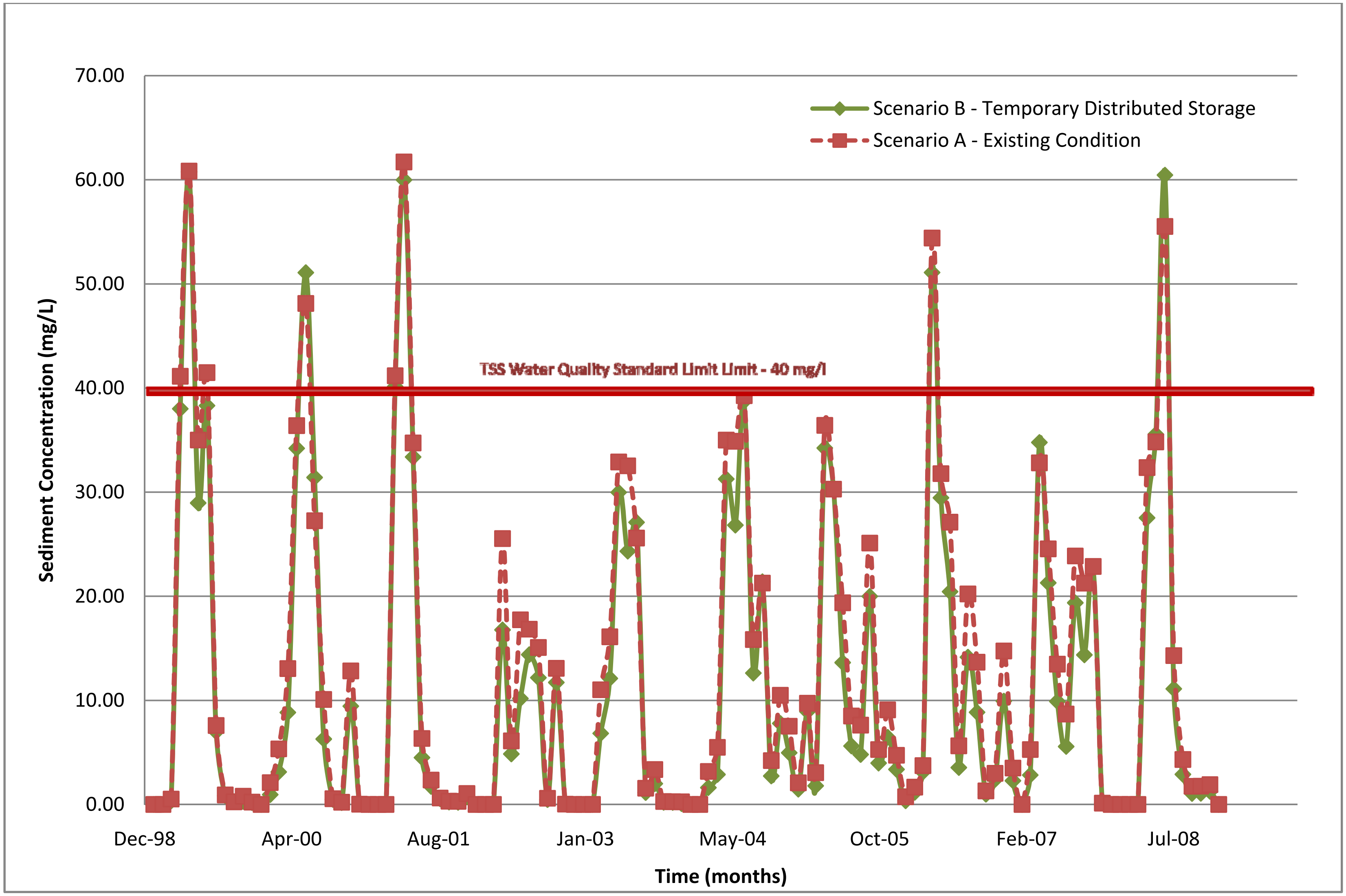


Figure 20: Dobbins Creek - Scenario B: Temporary Distributed Storage Monthly Average TSS Concentration Graph (1999 – 2008)



Estimated Cost

The estimated cost for implementing this scenario was addressed as follows:

- Costs associated with the flood reduction sites were taken for the cost data provided in the reports for the two sites.
- Cost associated with the wetland restoration sites will be based on land acquisition cost of $5,000 per acre (Burnet, 2010). It is assumed that design and construction is $3,000 per acre.
- Costs associated with the temporary storage were derived from the reconnaissance level cost estimate presented in the WMP. The information presented assumes CRWD staff would complete the engineering design and construction observation and administration.

Flood Sites

Site 1: Cost Estimate (Jones,Haugh & Smith Inc - Site 1, 2009)

Land Acquisition	$49,000
Design	$15,000
Construction	$55,640
Miscellaneous	$26,360
Total Start-Up Cost	$131,000

Site 2: Cost Estimate (Jones, Haugh & Smith Inc - Site 2, 2009)

Land Acquisition	$ 5,000
Design	$25,000
Construction	$148,000
Miscellaneous	$39,500
Total Start-Up Cost	$232,800

Wetland Restoration Sites

Land Acquisition (70ac)	$350,000
Design/Construction ($3,000/ac)	$210,000
Contingency (30%)	$168,000
Total Cost	$728,000

Temporary Storage Sites

WMP Watershed No.		SWAT Subbasin	WMP Reported Cost
Dbbn	30	22/26	$102,000
Dbbn	31	13	$10,000
Dbbn	15	11	$135,000
Dbbn	16	7	$0
Dbbn	17	5	$46,000
Dbbn	18	5	$13,000
Dbbn	19	12	$206,000
Dbbn	20	12	$7,000
Dbbn	21	12	$7,000
Dbbn	48	30	$0
Dbbn	49	34	$0
Dbbn	50	37	$9,000
Dbbn	51	37	$7,000
Dbbn	10	1	$383,000
Dbbn	11	6	$36,000
Dbbn	7	3	$21,000
		Total	**$982,000**

Total Cost

Flood Reduction Sites	$363,800
Wetland Restoration Sites	$728,000
Temporary Storage Sites	$982,000
Total	$2,073,800

Implementation Challenges

There are two transparent implementation challenges – money and public perception.

The flood reduction sites and the wetland restoration sites will require a substantial amount of capital for CRWD to acquire properties, design and construct. A phased approach would be a good way to reduce the fiscal burden of implementing this scenario. Public perception surrounding down sizing culverts to manufacture temporary storage areas has not been favorable. The scale of the WMP study required large area flooding for durations longer than stakeholders were willing to tolerate. The reduced magnitude presented in this report may be more palatable.

Scenario C – Perennial Vegetation

Description

As the price of oil increases, the United States and other nations are researching and developing alternative fuel options. These alternative fuel options have included corn-based ethanol and cellulosic ethanol. The option being considered here is cellulosic ethanol which is derived from switchgrass and other perennial vegetation.

Looking at the North Branch, switchgrass was planted on agricultural lands within that watershed. Subwatersheds contributing to the North Branch were ranked based on the sediment yield rate from the Existing Condition model (Table 12). The ranked data were then partitioned into four sections (50%, 60%, 75% and 100%) based on percentage of area draining to the North Branch (Table 12).

Table 12: Dobbins Creek North Branch Sediment Yield Ranking

Subbasin	Area (km2)	Sediment Yield (t/ha)	Percent of Area	Cumulative Percent of Area
9	1.051	8.56	2%	~ 50%
6	0.793	8.42	2%	
12	4.684	7.98	9%	
1	2.660	7.96	5%	
7	0.638	7.76	1%	
10	2.943	6.41	6%	
17	3.815	6.38	8%	
22	5.034	6.11	10%	
2	2.373	6.06	5%	
4	4.561	5.93	9%	~ 60%
8	2.036	5.88	4%	75%
11	4.479	5.84	9%	
16	2.104	5.66	4%	
3	4.629	5.64	9%	100%
5	4.969	4.81	10%	
14	3.081	4.79	6%	

Agricultural areas were converted to switchgrass starting with 50% of the watershed area, then 60 percent and so on until 100 percent. Each time additional area was converted to switchgrass, the output was checked to see if water quality standards were met. Water quality standards were not met until 100 percent of the area draining to the North Branch was converted (Figure 23).

Computed Water Quality Benefits

Implementing this scenario resulted in a reduction in TSS concentrations, as is illustrated in Figure 23. Over the 10-year period, all monthly average TSS concentrations were reduced to within an acceptable range, satisfying Minnesota Statue 7050. The scenario also produced reductions in runoff as shown in Figure 22.

Estimated Cost

The cost associated with implementing this scenario was derived using the crop production from SWAT model outputs for this scenario and Scenario A – Existing Conditions. Presented in Table 13 below is the expected annual revenue stream over the 10-year period for the Scenario A – Existing Condition with crops of corn and soybean and Scenario C with perennial vegetation. Converting crops from corn/soybean to switchgrass would cost growers an estimated $3,955,325, as shown on Table 13.

Table 13: Dobbins Creek Scenario C_ Perennial Vegetation Cost Estimate

Crop	Yield (bushels/ac)	Production (bushels)	Unit Price[3]	Total Revenue
Existing Conditions				
Soybeans	85	331,585	$9.65	$3,199,795
Corn	130	1,025,050	$3.40	$3,485,170
			Total	**$6,684,965**
Proposed Conditions				
Switchgrass	3.86	45,494	$ 60.00	$2,729,638
			Total	**$2,729,638**
			Difference	**$3,955,325**
Area (ac) Soybeans		3,901		
Area (ac) Corn		7,885		
Total Area(ac)		**11,786**		

[3] (USDA, 2009)

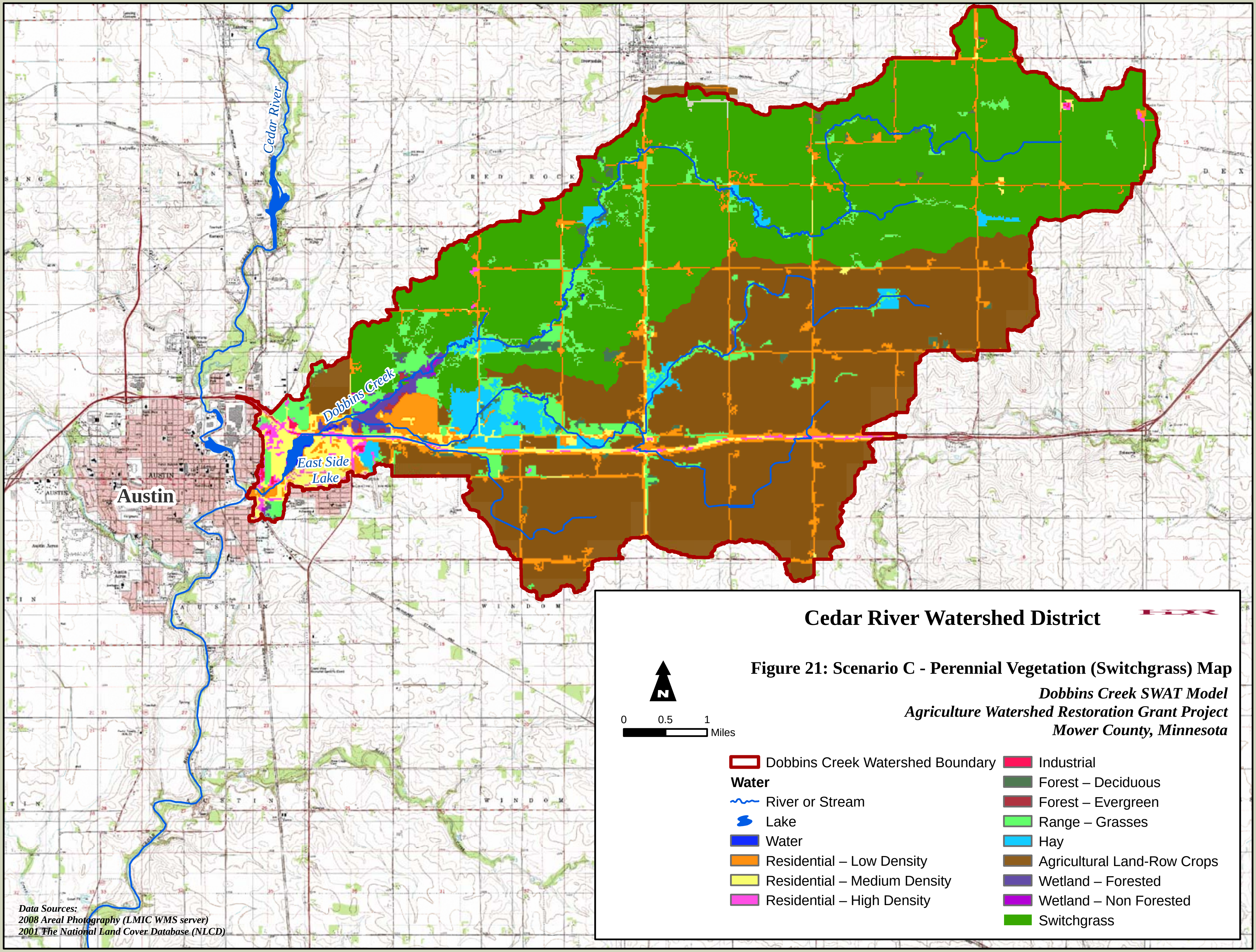


Figure 21: Scenario C - Perennial Vegetation (Switchgrass) Map

Dobbins Creek SWAT Model
Agriculture Watershed Restoration Grant Project
Mower County, Minnesota

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Figure 22: Dobbins Creek - Scenario C: Perennial Vegetation Monthly Average Surface Runoff Graph (1999 – 2008)

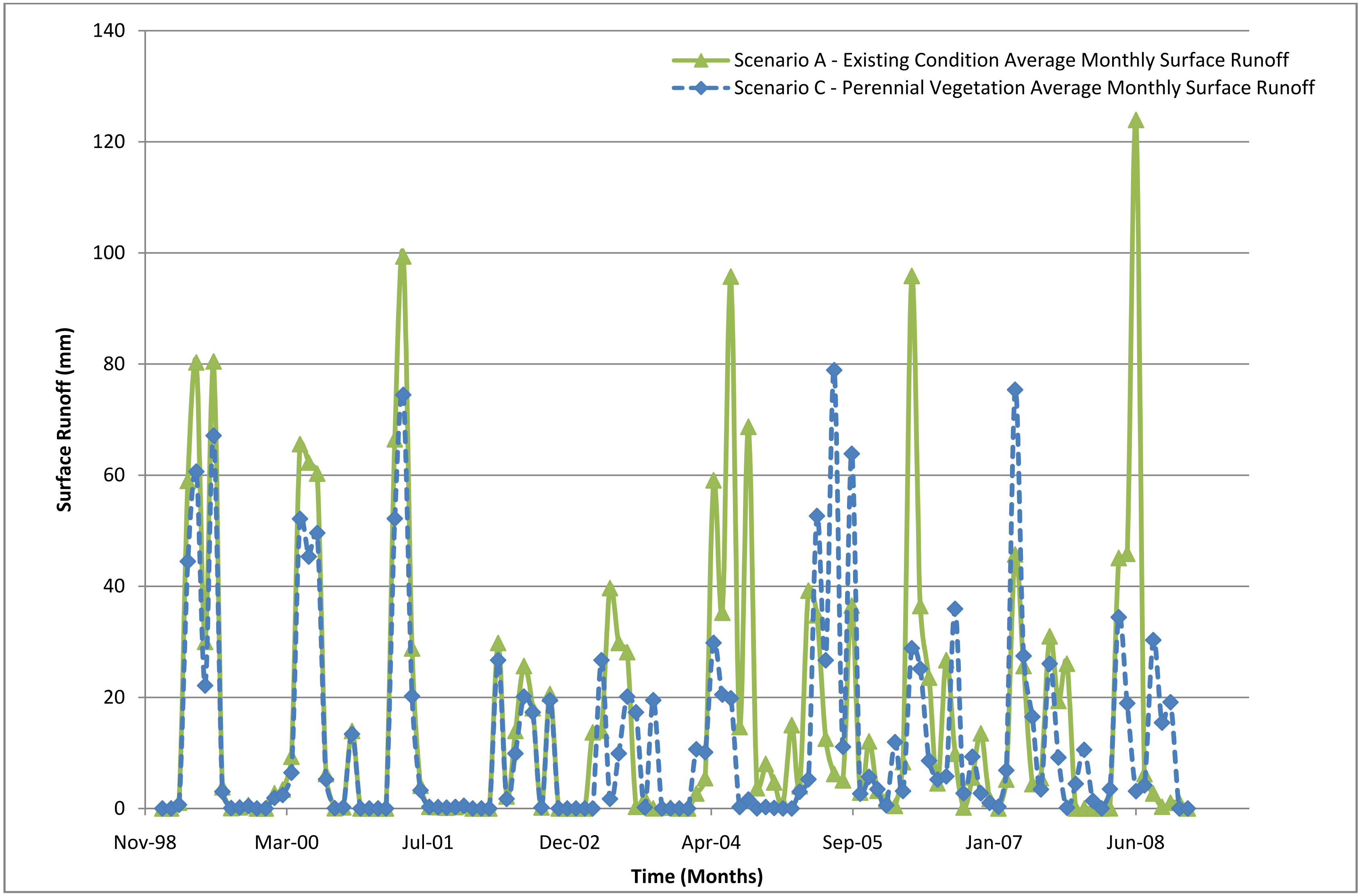
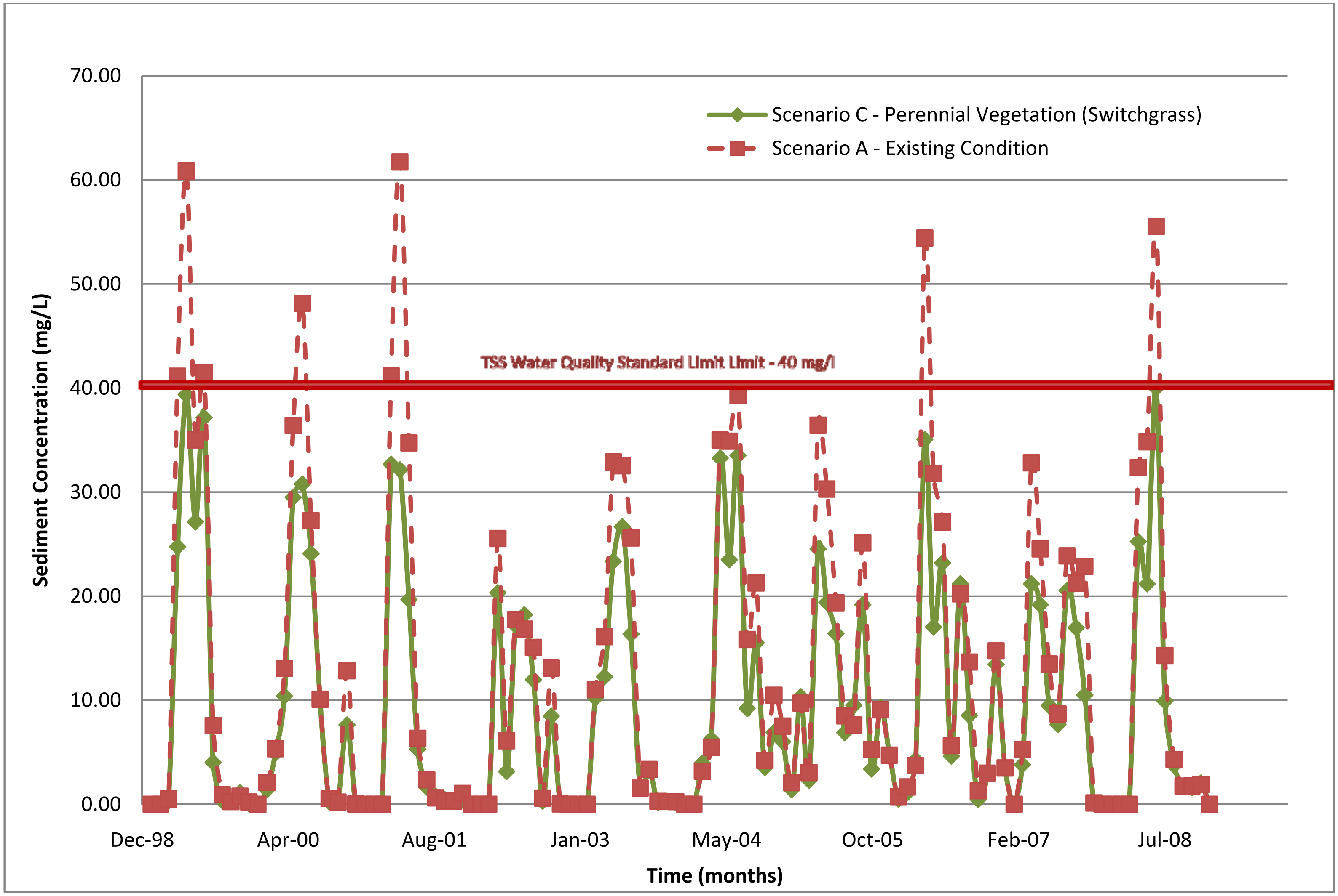


Figure 23: Dobbins Creek - Scenario C: Perennial Vegetation Monthly Average Sediment Concentration Graph (1999 – 2008)



Implementation Challenges

As a part of this project, CRWD staff conducted a survey of local farmers to determine what BMPs of land management practices would they most likely implement, if given the option and financial incentives (Appendix B). One of the options specified on the survey was converting their crops to perennial vegetation. Although the perennial vegetation option was analyzed, survey results indicated that farmers in this region are less likely to convert from corn or soybeans to switchgrass/perennials. In addition, the program cost necessary to offset the annual loss in revenue is high relative to the CRWD 2010 – 2018 average annual operating budget of $880,444 (Cedar River Watershed District, 2009).

Scenario D – Erosion Control

Description

Controlling erosion is critical to restoring water quality Dobbins Creek. Erosion control, prevention or management reduces the transport and delivery of sediment to the stream. According to the Stream Survey Report and CRWD, there are estimated 1,014 meter (3,328 lineal feet) and 98 square meters (1,050 square feet) of bank erosion along the north and south branch, respectively (Hanson - Stream Report, 2008). Bank erosion coupled with erosion from land management practices results in increased sediment deposition in tributary streams and the main channel.

In an effort to address this problem, the following erosion control best management practices were implemented in this scenario: conservation tillage and stream bank restoration. Conservation tillage was considered over 100 percent on agricultural land draining to the North Branch. In addition, streambanks within the North Branch would be restored. First, guided by CRWD staff, eroded sections of the creek would be restoring using revetment projects along the 1,014 m (3,328 ft) length of the channel upstream of East Side Lake. Then, implement Newberry Rock Riffles in selected stream sections (1, 7, 10, 12, 17, 22, and 25) to control grade, reduce velocity and trap sediment. Figure 24, provides a graphical illustration of the erosion control best management practices employed in this scenario.

Computed Water Quality Benefits

Implementing this scenario resulted in a reduction in TSS concentrations along the impaired reach of the creek as is illustrated in Figure 26. Over the 10-year period, monthly average TSS concentrations were reduced to within an acceptable range, satisfying Minnesota Statue 7050. The scenario also produced a reduction in runoff as shown in Figure 25.

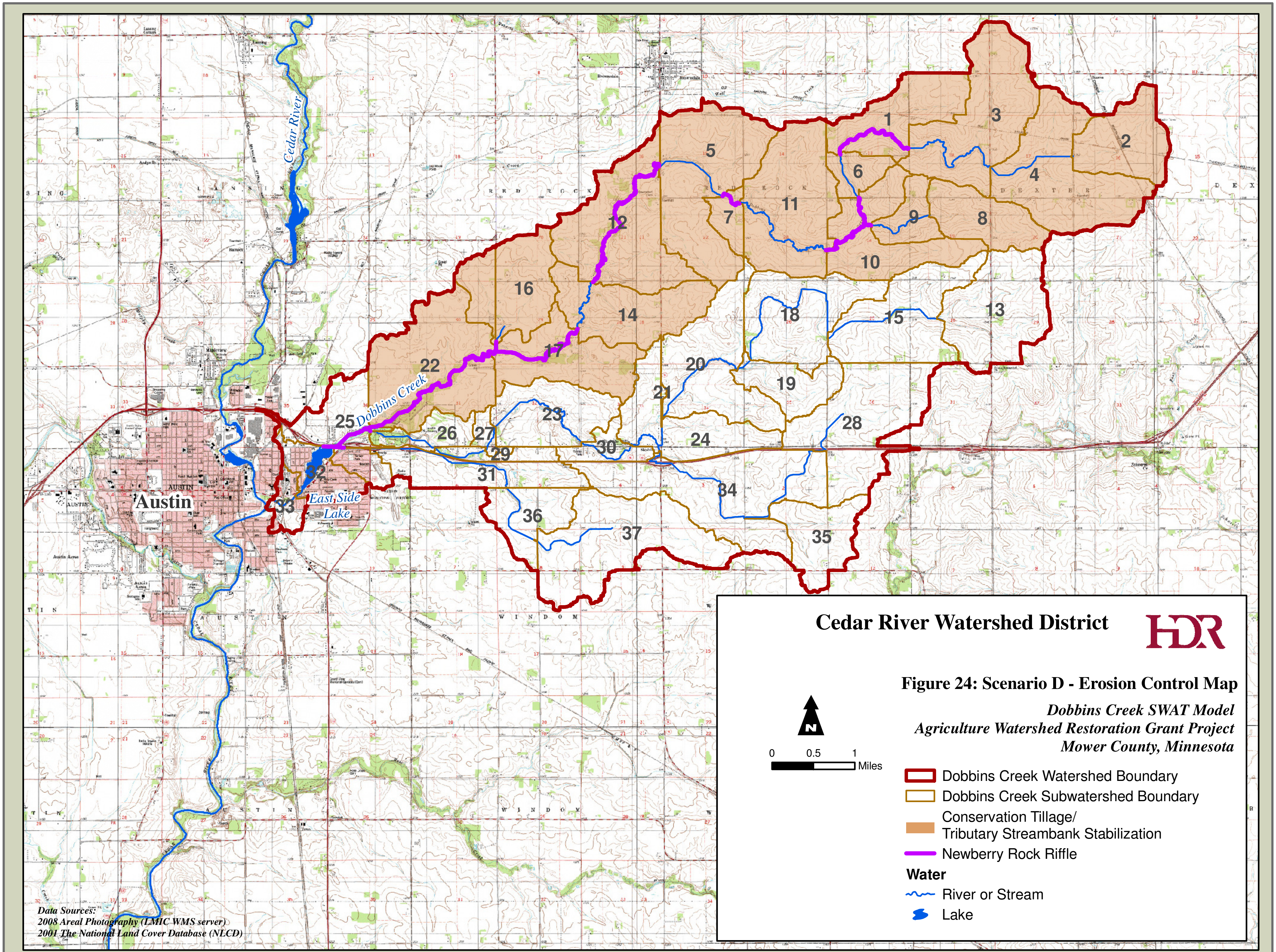


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Figure 25: Dobbins Creek - Scenario D: Erosion Control Monthly Average Surface Runoff Graph (1999 – 2008)

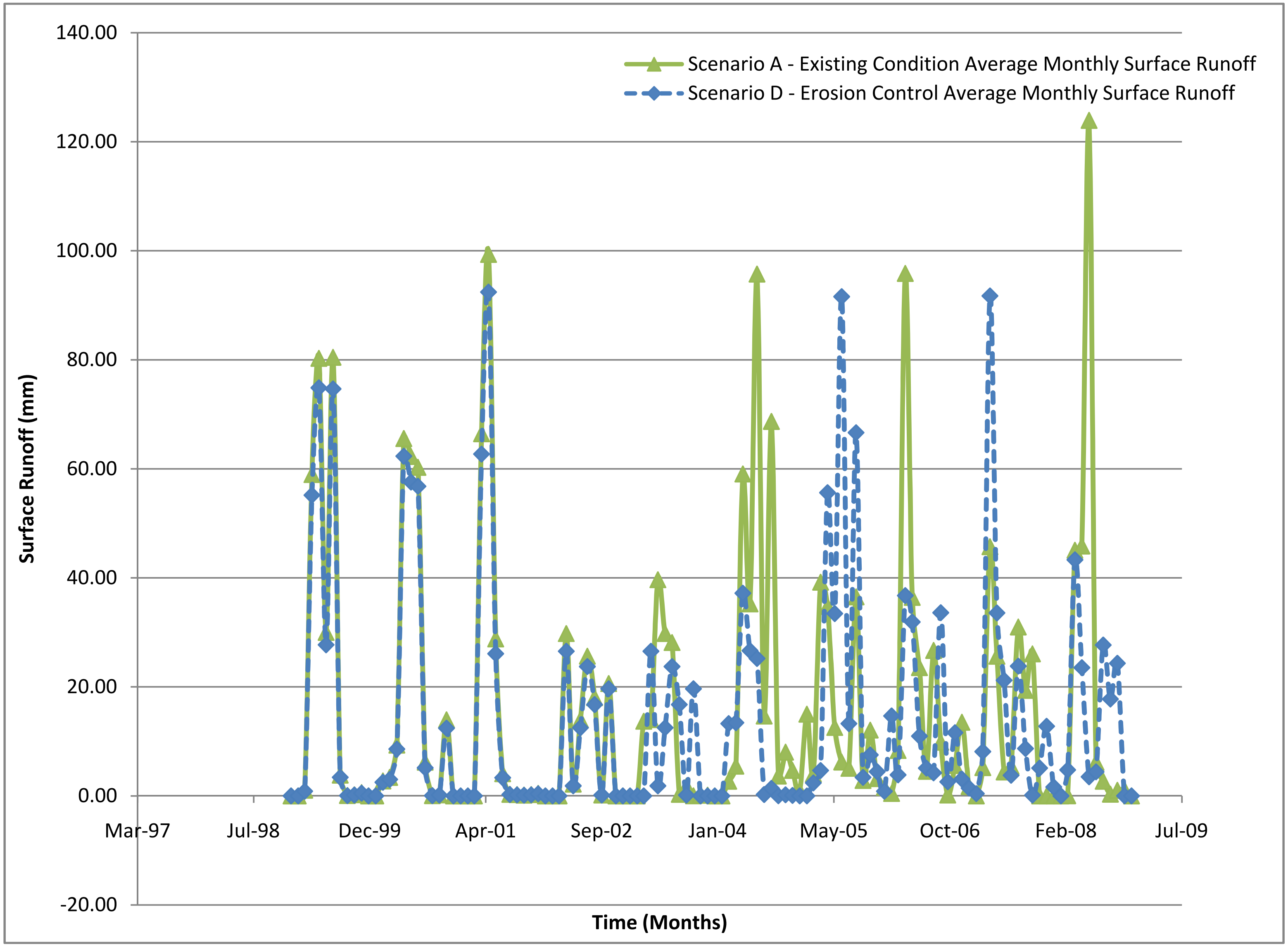

Figure 26: Dobbins Creek - Scenario D: Erosion Control Monthly Average TSS Concentration Graph (1999 – 2008)

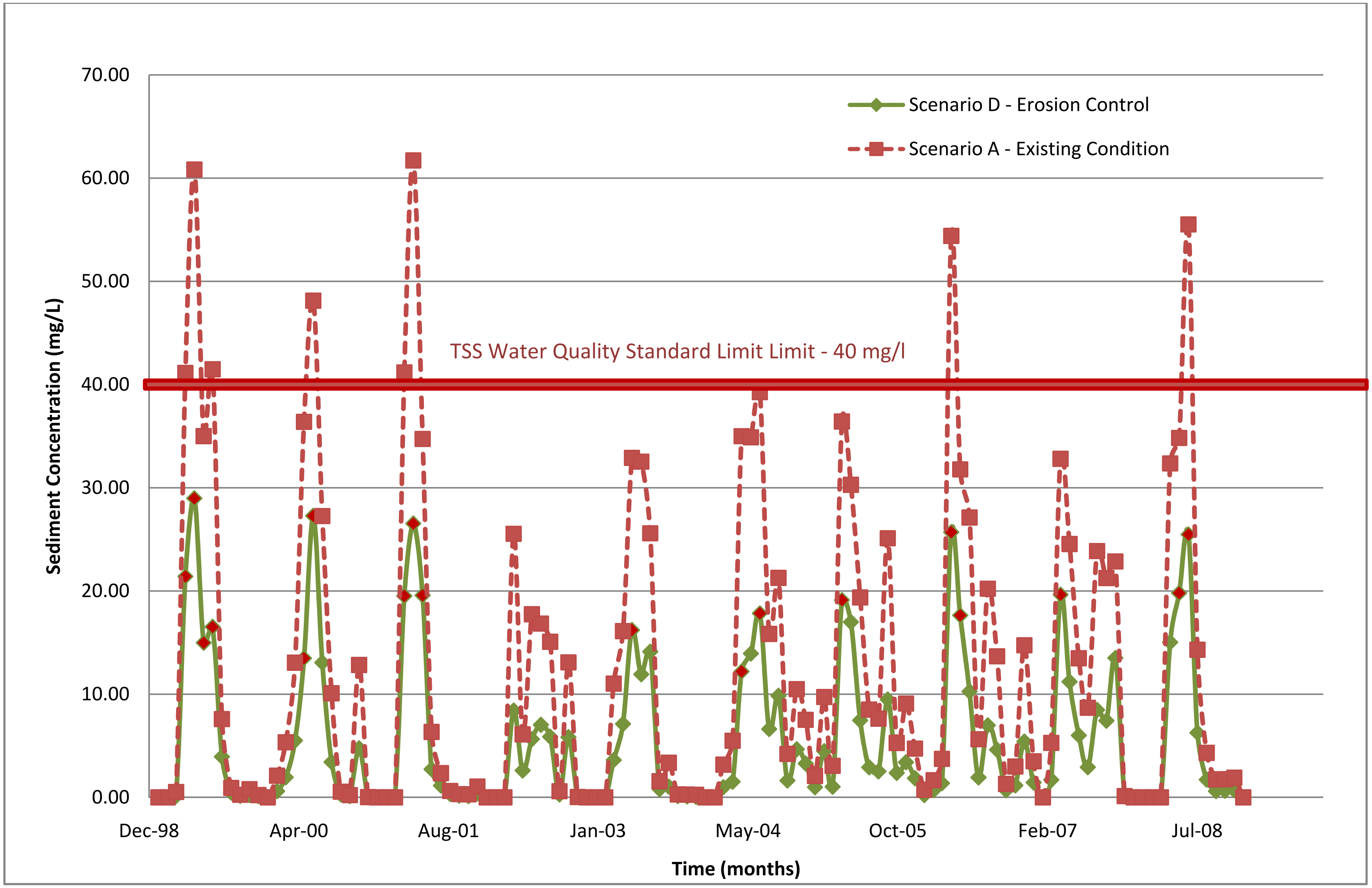

Table 14: Dobbins Creek Scenario D – Cost Estimate

North Branch				Contingencies		
Item	Quantity	U/I	Unit Price	Extended Amount	%	Contingency Amount
Grade Control and Scour Protection						
Riffles , 30'x10' – Reach 1	7	EA	$3,700	$25,900	30%	$7,770.00
Riffles , 30'x10' – Reach 7	2	EA	$3,700	$7,400	30%	$2,220
Riffles , 30'x10' – Reach 10	7	EA	$3,700	$25,900	30%	$7,770
Riffles , 50'x20' – Reach 12	7	EA	$7,070	$49,490	30%	$14,847
Riffles , 50'x20' – Reach 17	8	EA	$7,070	$56,560	30%	$16,968
Riffles , 50'x20' – Reach 22	7	EA	$7,070	$49,490	30%	$14,847
Riffles , 50'x20' – Reach 25	3	EA	$7,070	$21,210	30%	$6,363
Deflectors	75	EA	$ 870	$65,250	30%	$19,575
			Subtotal	**$301,200**		**$90,360**
Riparian Restoration						
Bank Stabilization	3,328	LF	$50	$166,400	30%	$49,920
Log/Rootward/Boulders	133.3	LF	$40	$5,332	30%	$1,599.60
Tree saplings with grow tube	15,000	EA	$ 9	$135,000	30%	$40,500
			Subtotal	**$306,732**		**$92,019.60**

Implementation Challenges

As with Scenario B, the implementation challenge is financial. CRWD would need funds to pay for engineering and construction services associated with the design and construct of the Newberry Rock Riffles and to buy the items need for the riparian restoration/streambanks stabilization.

Scenario E – Combination

Description

The CRWD created a survey for local farmers that asked what they would most likely implement, if given the options and financial incentives. The results of the survey are presented in Appendix B. The survey provided critical implementation information which allowed evaluation of practices that farmers would actually implement.

CRWD survey pool was made up of five (5) farmers and the City of Austin - Nature Center, chosen to represent the cross-section of views relating to land management in the watershed. The result of the survey suggests that:

- Approximately 20 percent of farmers would voluntarily implement conservation tillage or no-till options. If compensated, that number rises to 80 percent.
- If compensated:

- 80 percent would consider flowage easements
- 60 percent would consider flood reduction sites
- 25 percent would consider wetland restorations (include the Nature Center)
- 17 percent would consider streambank restorations

The practices measured in this scenario were based on responses received from the surveys; the ability of these practices to meet TSS water quality standards and reduce peak flows by 10 percent; and the availability to get grant to offset the financial burden. Using these as a basis, the following practices were used in Scenario E:

- Flood Reduction Sites
- Wetland Restoration Sites
- Phase 1- Temporary Storage Sites (Table 10)
- Conservation Tillage

These practices are also presented graphically on Figure 27.

Computed Water Quality Benefits

Over the 10-year period of record, monthly average TSS concentrations values were reduced by 34 percent, which satisfies Minnesota Statue 7050. In addition, peak flow readings were reduced by 23 percent. The highest average peak flow of 305 cubic feet/second (May 2001) was reduced by 10 percent. The other three notable average peak flows greater than 200 cfs were reduced by 19 – 25 percent.

Estimated Cost

The cost to implement this scenario is presented below.

Flood Reduction Sites

Site 1: Cost Estimate (Jones,Haugh & Smith Inc - Site 1, 2009)

Land Acquisition	$49,000
Design	$15,000
Construction	$55,640
Miscellaneous	$26,360
Total Start-Up Cost	$131,000

Site 2: Cost Estimate (Jones, Haugh & Smith Inc - Site 2, 2009)

Land Acquisition	$45,000
Design	$25,000
Construction	$148,000
Miscellaneous	$39,500
Total Start-Up Cost	$232,800

Wetland Restoration Sites

Land Acquisition (70ac)	$350,000
Design/Construction ($3,000/ac)	$210,000
Contingency (30%)	$168,000
Total Cost	$728,000

Temporary Storage Sites

WMP Watershed No.		SWAT Subbasin	WMP Reported Cost
Dbbn	10	1	$383,000
Dbbn	7	3	$21,000
Dbbn	17	5	$46,000
Dbbn	18	5	$13,000
Dbbn	11	6	$36,000
Dbbn	16	7	$0
Dbbn	15	11	$135,000
Dbbn	19	12	$206,000
Dbbn	20	12	$7,000
Dbbn	21	12	$7,000
Dbbn	30	22	$102,000
		Total	**$956,000**

Total Cost

Flood Reduction Sites	$363,800
Wetland Restoration Sites	$728,000
Temporary Storage Sites	$956,000
Total	$2,047,800

Implementation Challenges

A $2 million capital investment during a time when budget challenges are being seen in every arena from government to residential household presents a major hurdle. In addition, CRWD is obligated to address water quality problems affecting regulated uses of the Dobbins Creek by state and federal laws. These two items present a picture that is being seen by many other entities that are faced with unfunded mandates.

But, the feasibility and practicality of the BMPs considered in this scenario makes the task of securing funding less daunting. The water quality and quantity benefits of implementing this scenario provide the perfect framework for soliciting funding partners. Below is a list of a few funding opportunities available to CRWD to implement these BMPs:

- DNR Flood Damage Reduction Program (DNR-FDR Program, 2010): This program provides financial, planning, and technical assistance to reduce recurring flood damages by promoting the sound management and appropriate use of floodplain and riparian areas. The program requires 25 percent matching funds from local government units.
- Conservation Reserve Enhancement Program (CREP) (USDA-FSA, 2009): This is a voluntary land retirement program that helps agricultural producers protect environmentally sensitive land, decrease erosion, restore wildlife habitat, and safeguard ground and surface water. CREP provides payments to participants who offer eligible land.
- EPA Five- Star Restoration Program (US EPA - 5 SRP, 2009): The program provides challenge grants ($5,000 to $20,000), technical support and opportunities for information exchange to enable community-based restoration projects.
- USDA Wetland Reserve Program and BWSR Reinvest in Minnesota (RIM-WRP, 2009): The program provides funding to restore critical wildlife habitat on privately owned lands while improving water quality, reducing flood damage potential, providing economic assistance to landowners, and providing other environmental and economic benefits. In 2009, the total amount available for projects was $41 million.
- DNR Pheasant habitat improvement program (PHIP) (DNR - PHIP, 2010): This program provides cost-sharing to landowners for management practices that improve pheasant habitat through the development, restoration, and maintenance of suitable habitat for ring-necked pheasants, which includes the establishment of food plots (primarily corn or sorghum), nesting cover, woody cover and wetland restoration.
- US Fish and Wildlife Service - North American Wetland Conservation Act (USFWS, 2010): This program provides matching grants (not to exceed $75,000) to organizations and individuals who have developed partnerships to carry out wetlands conservation projects in the United States, Canada, and Mexico for the benefit of wetlands-associated migratory birds and other wildlife.

In addition to the grant opportunities noted above, the state of Minnesota through BWSR provides countless other funding mechanisms including the conservation drainage program, runoff reduction grants, and clean water assistance grants.

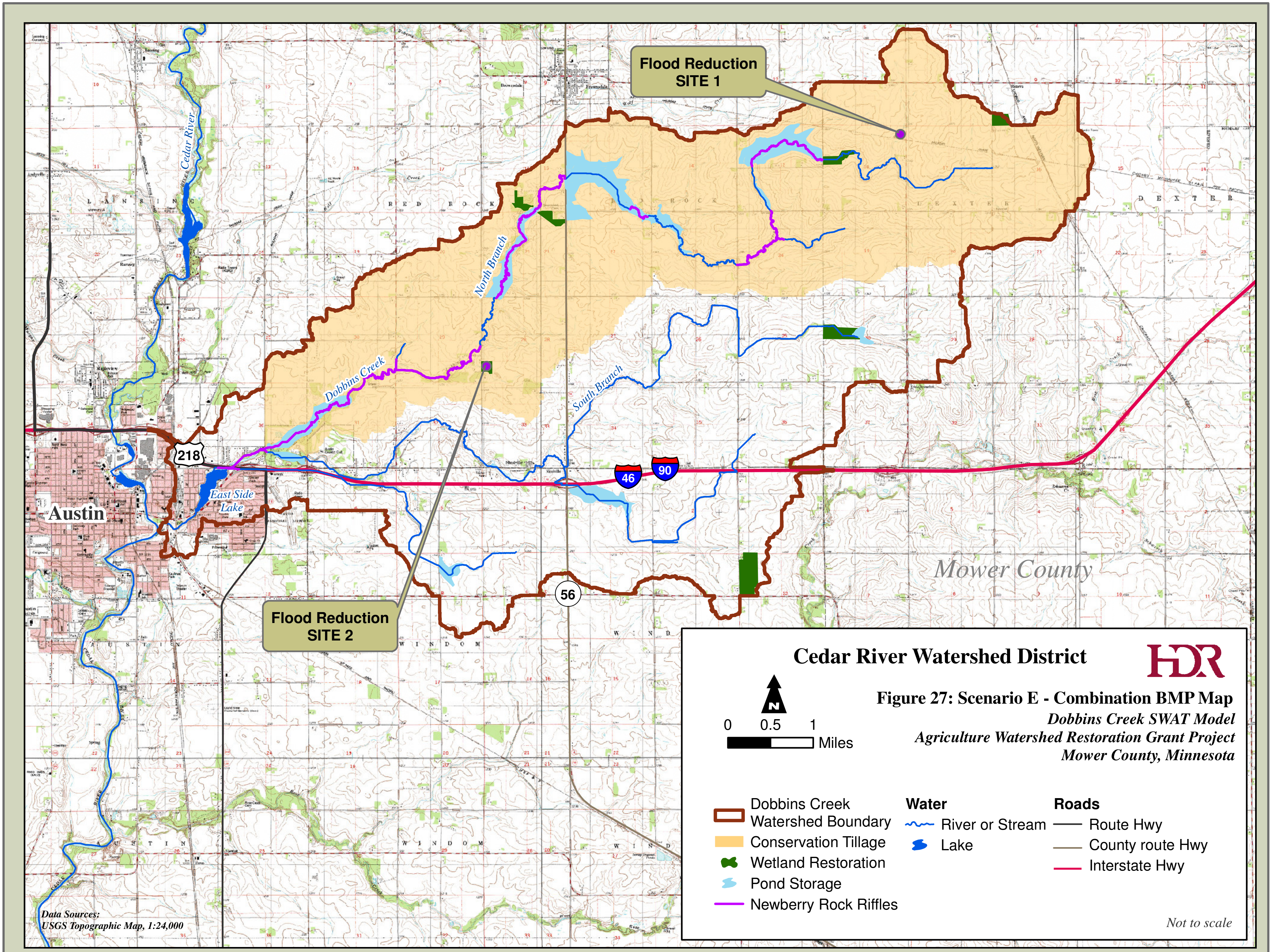

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Figure 28: Dobbins Creek - Scenario E: Combination Practices Monthly Average Peak Flow Graph (1999 – 2008)

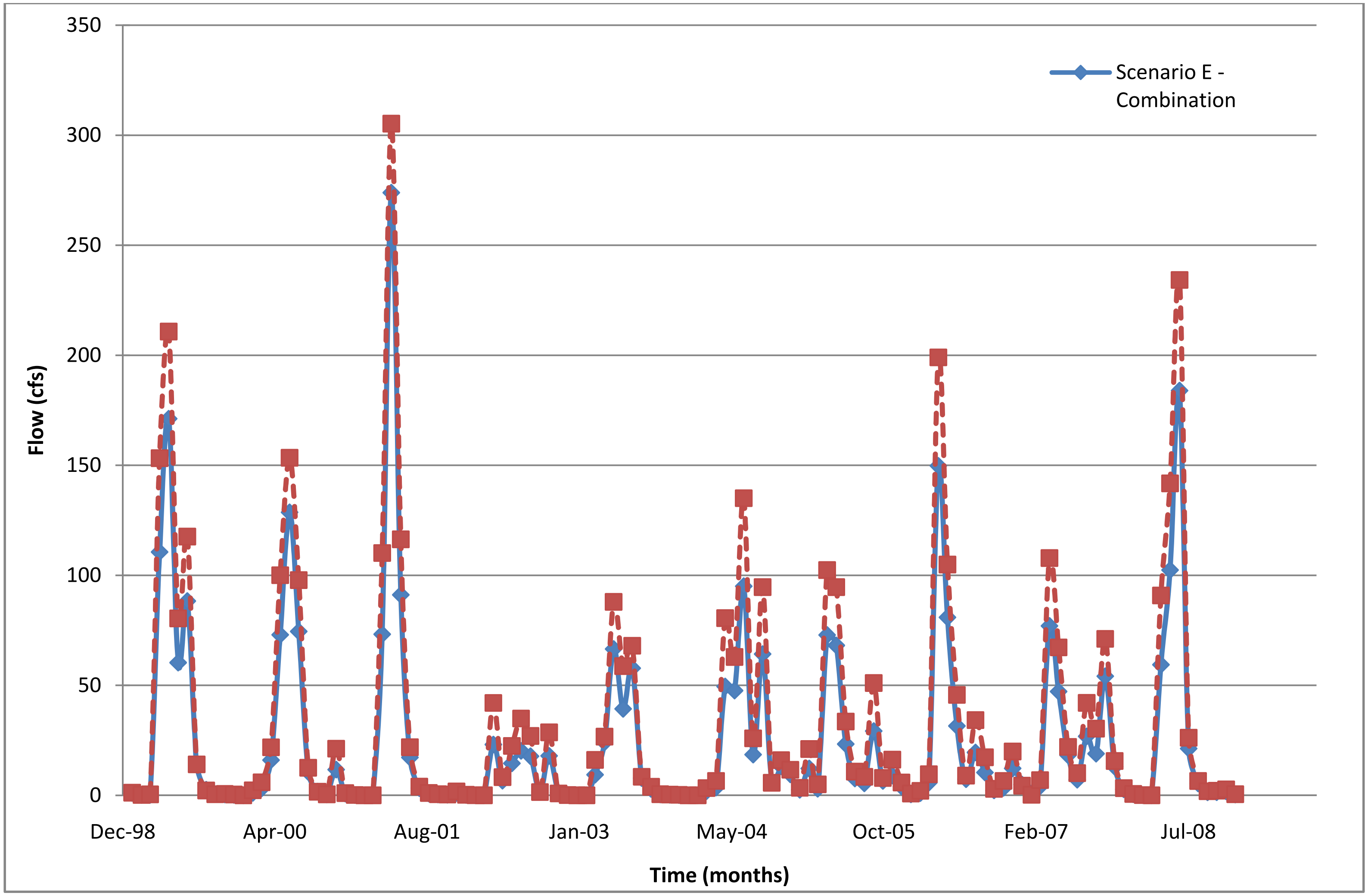
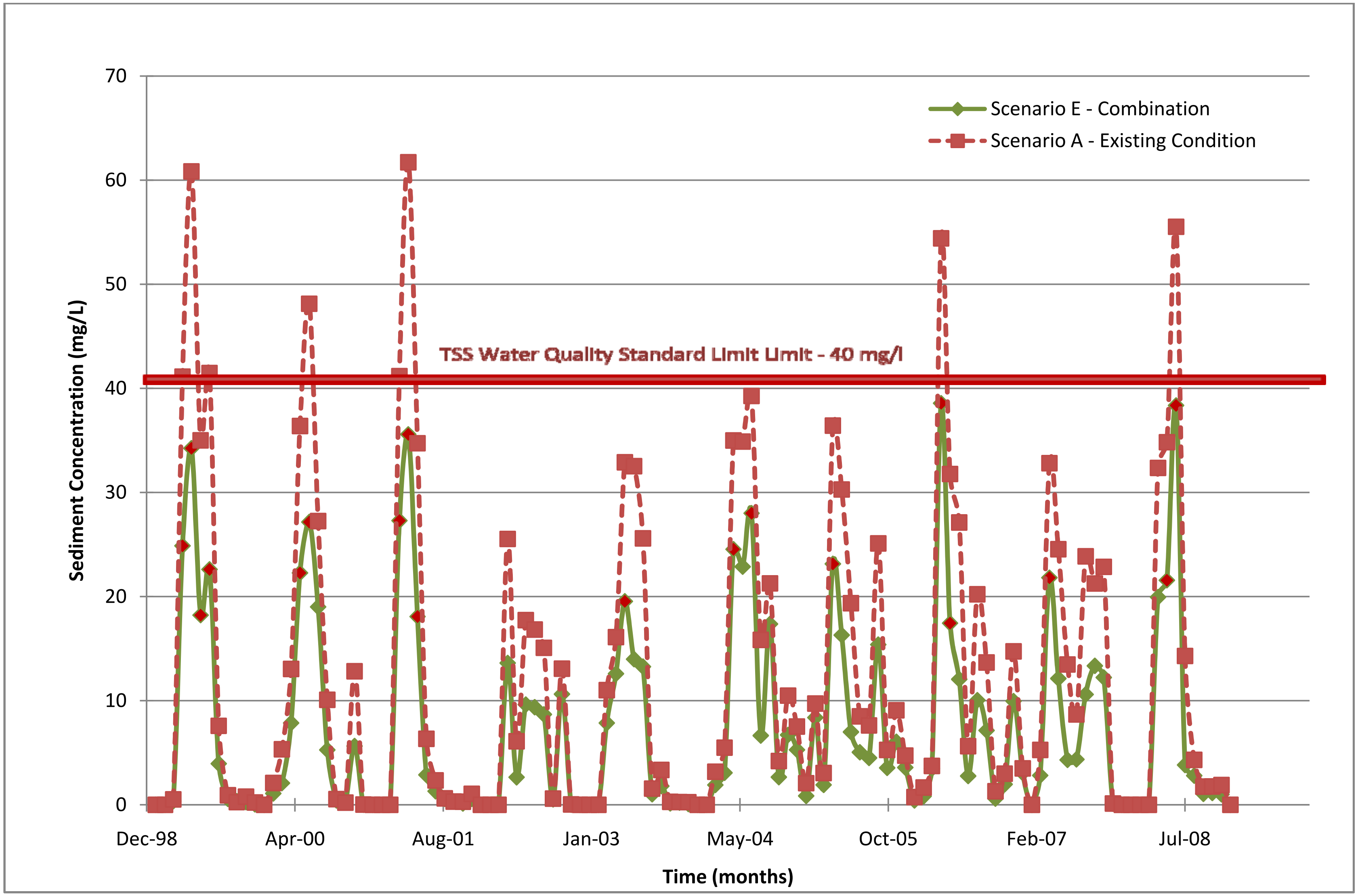


Figure 29: Dobbins Creek - Scenario E: Combination Practices Monthly Average TSS Concentration Graph (1999 – 2008)



Conclusion

The CRWD, in partnership with BWSR, undertook the application of a SWAT model to model the Dobbins Creek watershed system. The scope of this project was to use SWAT to simulate hydrologic and sediment dynamics on a continuous simulation to identify potential system changes or BMPs needed to meet TSS water quality standards in the Dobbins Creek Watershed. Using the calibrated SWAT model, five broad scenarios were evaluated to determine their ability to reduce peak flows and TSS transported through the Dobbins Creek system. The primary focus of this project was sediment reduction; however, best management practices selected for implementation under these scenarios also considered their ability to reduce peak flow.

The goal of these scenarios, as documented by CRWD, is to meet applicable turbidity/TSS state surface water quality standards. Dobbins Creek is a class 2B stream with a turbidity limit of 25 NTUs which translated to between 30 – 40 mg/l of TSS. The three branches of Dobbins Creek, North, South and Unnamed, were examined using the calibrated model to determine if those reaches were meeting current water quality standards based on monthly averages of TSS concentrations over a 10-year period (1999-2008). The South Branch consistently meets water quality standards. While the Unnamed Branch, violates the standard by about 5 mg/l one month over the 10-year period. On the other hand, North Branch violates the water quality standard five times over the 10-year period with exceedance of the standard ranging from about 7 mg/l to 35 mg/l. As a result, the focus of BMP implementation was the North Branch of Dobbins Creek. The five (5) scenarios are summarized below.

A. <u>Existing Condition</u> - This scenario called for CRWD, residents and stakeholders to maintain existing practices (crop rotations, land management, and fertilizer application). This scenario documented no improvement to infrastructure, farming practices or the main/tributary channels. As a result, North Branch and Unnamed Branch do not meet TSS water quality standards.

B. <u>Temporary Distributed Storage</u> – This scenario implement seven wetland restoration sites identified by CRWD, two sites from Flood Reduction Feasibility Studies, and seventeen(17) temporary storages sites from the WMP. The principal goal of this scenario was to reduce the continuous simulated peak flows (for the 10-year period) by 10 percent. Again, the focus of this goal was not to meet the water quality standard but the reduce peak flows by 10 percent. Implementing this scenario provided a 10 percent reduction in continuous simulated peak flows from Scenario A. TSS concentrations reduced by 4-5 percent in some months and in others by 50 – 70 percent. Although there were reductions in TSS concentrations, they were not enough the meet water quality standards. The cost to implement this scenario would be approximately $2.1 million. The primary challenge to implementing this scenario is financial and public perception. The flood reduction sites and the wetland restoration sites will require a substantial capital investment from CRWD to acquire properties, design and construct. Also, public perception surrounding down sizing culverts to manufacture temporary storage areas has not been favorable. The scale of the WMP was so larger that stakeholders were unwilling to consider. However, the reduced magnitude presented here may be more palatable.

C. Perennial Vegetation: The goal of this scenario was for the watershed to meet TSS water quality standards. To meet TSS water quality standards, 100 percent of the agricultural land in the North Branch subwatershed was converted from corn or soybean crops to switchgrass. The cost to implement that conversion would be about $4 million. Result from the survey indicated that farmers in this region are less likely to convert from corn or soybeans to switchgrass/perennials. In addition, the programming cost necessary to offset the annual loss in revenue is high relative to the CRWD 2010 – 2018 average annual operating budget of $880,444 (Cedar River Watershed District, 2009).

D. Erosion Control: The following erosion control best management practices were implemented in this scenario to meet TSS water quality standard: conservation tillage and stream bank restoration. Conservation tillage was employed over 100 percent of agricultural land draining to the North Branch. In addition, streambanks within the North Branch would be restored though revetment projects along the entire 1,014 m (3,328 ft) length of the channel from East Side Lake. Then, Newberry Rock Riffles were implemented in stream sections (1, 7, 10, 12, 17, 22, and 25) to control grade, reduce velocity and trap sediment. The cost of implementation is about $ 790,311. As with Scenario B, the implementation challenge is financial. CRWD would need funds to pay for engineering design and construction services associated with the Newberry Rock Riffles; and to buy the items need for the riparian restoration/streambank stabilization.

E. Combination: The practices considered in this scenario were based on responses received from the surveys; the ability of these practices to meet TSS water quality standards, reduce peak flows by 10 percent; and the availability of grant programs to offset the financial burden. Using that as a basis, the following practices were used in Scenario E:

- Flood Reduction Sites
- Wetland Restoration Sites
- Phase 1- Temporary Storage Sites (Table 10)
- Conservation Tillage

Over the 10-year period of record, monthly average TSS concentrations values were reduced by 34 percent, which satisfied Minnesota Statue 7050. In addition, peak flow readings were reduced by 23 percent. The cost to implement this scenario is about $2 million. Although, the price tag is high, there are several grants and funding mechanisms available to CRWD to offset the cost. This scenario is practical because it builds on previous studies, it has support from stakeholder and it addresses both water quality and quantity concerns. It is feasible because the BMPs suggested here and the results of this report provide CRWD the framework and evidence needed to gain financial support.

Recommendations

Considering the findings presented in this report and the water quality implications to Dobbins Creek, the following actions are recommended:

- Apply for Phase 3 funding and other applicable funding to implement Scenario E. Use the funds received to
    1. Revise Site 1 and 2 Flood Reduction designs to incorporate water quality features
    2. Complete Phase 1 site assessments/feasibility studies on the seven (7) identified wetland restoration sites.
    3. Complete engineering design and construction associated with the WMP temporary storage sites incorporated in the study.
- Complete an in-depth water quality study of East Side Lake to determine nutrient and sediment budgets.
- Continue monitoring efforts and integrate procedures that will aide obtaining flow and TSS data during high flow events.
- Education and engage stakeholders to voluntarily participate in runoff reducing practices, such as, conservation tillage or no-till.

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Appendix A: Table A1

Table A1. Dobbins Creek Feedlot Data

PREFERRED ID	Feedlot Name	Dairy	Beef	Veal	Swine	Horse	Sheep	Chicken	Duck
099-83271	Daniel Holst Farm				100				
099-83198	David A Krebsbach Farm					10			
099-83458	David Allen Farm					8			
099-83447	David Andree Farm		35		700			450	75
099-83270	David Holst Farm				596				
099-82977	Delmer Tapp Farm				560				
099-83252	Dennis Jax Farm	40			226				
099-83411	Diane Buckley Farm					3			
099-83213	Douglas Kiser Farm		15						
099-93966	Duane Anderson Farm				503				
099-83327	Francis Guiney Farm		20						
099-83230	Gary Kahler Farm						150		
099-82976	Gene Tapp Farm				328				
099-83357	George Finnegan Farm		80						
099-83067	Guy Rockwell Farm		13				230		
099-100193	Holden farms				2450				
099-83429	Jack Bergstrom Farm		14		280	2			
099-83431	Jack Bergstrom Farm		145						
099-83398	James Christian Farm		60		355				
099-83269	John Holst Farm	20							
099-93980	John Mueller Farm				247				
099-83158	Kathy & Joe Mayo Farm				375				
099-83594	Keith Ellis Farm				312				
099-83592	Keith Ellis Farm				700				
099-83026	Kenneth Schwebke Farm		5			5			
099-83428	LaVerne Bergstrom Farm				500				
099-82999	Myron Sorenson Farm		75						
099-83106	Phillip Oswald Farm		35						
099-83248	Richard Jax Farm	123	30		502				
099-82953	Richard Waldman Farm				580		300		
099-82927	Ron Wradislavsky Farm					11			
099-83082	Ronald Quill Farm		30						
099-83533	Russell M Linnett		20						
099-83440	Steven Bartelt Farm		25			40			
099-83356	Thomas Finnegan Farm		58						
099-83664	Tim Swegle Farm		7			7			
099-83057	William Rugg Farm		40						
	TOTAL	183	707	0	9314	86	680	450	75

Appendix B: Landowner Surveys

Dobbins Creek Landowner Survey

The CRWD is working on a study to evaluate land use practices in the Dobbins Creek area. There have been extensive studies in this area which show that there are concerns with the level of sediment getting into Dobbins creek. There are also resource concerns involved with numerous flood events. Dobbins is a very flashy watershed. In the past, it has been hit with heavy rain events which move very quickly over the land with a great deal of velocity. These events result in a variety of flood damage issues. We have unique opportunity to review the watershed in detail and look at specific best management practices could be used to alleviate some of the water quality and flood damage a problems. I will be asking a series of questions, trying to get an understanding of what BMP practices you may be interested in incorporating into your operation. We will have an excellent opportunity to offer a "taylor made" cost-share program to fit the needs of the producers in this area.

Name: Al Akkerman Twp. Red Rock Sec. Various

Have you ever enrolled in a cost-share program for the following practices?

	Cost Share	On Own	Current Practice?	
Wetland Restoration				
Flood Retention				
Stream Bank Restoration				
Buffer Strip				
Perennial Biofuel Crops				
Conservation Tillage		X		Have done No Till already
Nutrient Management Incentive		X		

Which practice would you consider putting on your farm (if appropriately compensated)

Wetland Restoration	
Flood Retention	
Stream Bank Restoration	
Buffer Strip	
Perennial Biofuel Crops	
Conservation Tillage	X
Nutrient Management Incentive	X
Other	Description:

What kind of incentives would it take for you or your neighbors to incorporate some of these practices?

$20/acre incentive to switch over

Would you be open to Land Retirement Programs? (YES) NO

If Yes – Would you prefer Easements or Land Sale? (Easements Land Sale)

Would you be open to Flowage Easements to temporarily impound water on a small area of land? (YES) NO

More Attractive to take out of production than do Flowage Esmnt.

Are there specific sites you may have in mind if funding was made available next spring? YES NO
Examples?

If Yes, Describe Practice: Approx. 2,000 acres

Location: Twp. Sec.

Other Notes: Already doing conservation tillage on his land. He thought that we could develop a program to encourage other landowners to change

Dobbins Creek Landowner Survey

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Name: City of Austin - Nature Center Twp. Red Rock Sec. 30

Have you ever enrolled in a cost-share program for the following practices?

	Cost Share	On Own	Current Practice?
Wetland Restoration		X	X
Flood Retention			
Stream Bank Restoration		X	X
Buffer Strip			
Perennial Biofuel Crops			
Conservation Tillage			
Nutrient Management Incentive			

Which practice would you consider putting on your farm (if appropriately compensated)

Wetland Restoration	X
Flood Retention	
Stream Bank Restoration	
Buffer Strip	
Perennial Biofuel Crops	
Conservation Tillage	
Nutrient Management Incentive	
Other	

Description: ______

What kind of incentives would it take for you or your neighbors to incorporate some of these practices? No Comment on Neighbors Needs for cost-share

Would you be open to Land Retirement Programs? (YES) NO

If Yes – Would you prefer Easements or Land Sale? (Easements) Land Sale

Would you be open to Flowage Easements to temporarily impound water on a small area of land? YES NO NA

Are there specific sites you may have in mind if funding was made available next spring? (YES) NO
Examples?

If Yes, Describe Practice: Wetland Restoration

Location: SW 1/4 Twp. Red Rock Sec. 30

Other Notes: Land is in agreement to be incorporated into Existing Nature Center over next year . . . or two

Site #1
Feasibility Study

Dobbins Creek Landowner Survey

The CRWD is working on a study to evaluate land use practices in the Dobbins Creek area. There have been extensive studies in this area which show that there are concerns with the level of sediment getting into Dobbins creek. There are also resource concerns involved with numerous flood events. Dobbins is a very flashy watershed. In the past, it has been hit with heavy rain events which move very quickly over the land with a great deal of velocity. These events result in a variety of flood damage issues. We have unique opportunity to review the watershed in detail and look at specific best management practices could be used to alleviate some of the water quality and flood damage a problems. I will be asking a series of questions, trying to get an understanding of what BMP practices you may be interested in incorporating into your operation. We will have an excellent opportunity to offer a "taylor made" cost-share program to fit the needs of the producers in this area.

Name: Les Tapp Twp. Dexter Sec. 7, 18

Have you ever enrolled in a cost-share program for the following practices?

	Cost Share	On Own	Current Practice?
Wetland Restoration			
Flood Retention			
Stream Bank Restoration			
Buffer Strip	X		
Perennial Biofuel Crops			
Conservation Tillage	X		
Nutrient Management Incentive			

Which practice would you consider putting on your farm (if appropriately compensated)

Wetland Restoration	
Flood Retention	X
Stream Bank Restoration	
Buffer Strip	X
Perennial Biofuel Crops	
Conservation Tillage	X
Nutrient Management Incentive	
Other	

Description: ____

What kind of incentives would it take for you or your neighbors to incorporate some of these practices? No Comment Made

Would you be open to Land Retirement Programs? (YES) NO

If Yes – Would you prefer Easements or Land Sale? (Easements) Land Sale

Would you be open to Flowage Easements to temporarily impound water on a small area of land? (YES) NO

Are there specific sites you may have in mind if funding was made available next spring? (YES) NO
Examples?

If Yes, Describe Practice: Flood Retention

Location: Dexter Twp. ____ Sec. 7, 18

Other Notes: Would like to do large scale retention project. open and willing to discuss Dobbins Creek Flood Feasability Study site #2

Dobbins Creek Landowner Survey

The CRWD is working on a study to evaluate land use practices in the Dobbins Creek area. There have been extensive studies in this area which show that there are concerns with the level of sediment getting into Dobbins creek. There are also resource concerns involved with numerous flood events. Dobbins is a very flashy watershed. In the past, it has been hit with heavy rain events which move very quickly over the land with a great deal of velocity. These events result in a variety of flood damage issues. We have unique opportunity to review the watershed in detail and look at specific best management practices could be used to alleviate some of the water quality and flood damage a problems. I will be asking a series of questions, trying to get an understanding of what BMP practices you may be interested in incorporating into your operation. We will have an excellent opportunity to offer a "taylor made" cost-share program to fit the needs of the producers in this area.

Name: Wayne DieKrager Twp. Red Rock Sec. 30

Have you ever enrolled in a cost-share program for the following practices?

	Cost Share	On Own	Current Practice?
Wetland Restoration	X		
Flood Retention			
Stream Bank Restoration			
Buffer Strip	X		
Perennial Biofuel Crops			
Conservation Tillage			
Nutrient Management Incentive			

Which practice would you consider putting on your farm (if appropriately compensated)

Wetland Restoration	
Flood Retention	
Stream Bank Restoration	
Buffer Strip	
Perennial Biofuel Crops	
Conservation Tillage	
Nutrient Management Incentive	
Other	X

Description: Suggested alternative crops such as Walnut tree plantings and incentives to promote

What kind of incentives would it take for you or your neighbors to incorporate some of these practices?

Did not think he had sites that would fit these criteria

Would you be open to Land Retirement Programs? (YES) NO

If Yes – Would you prefer Easements or Land Sale? (Easements) Land Sale

Would you be open to Flowage Easements to temporarily impound water on a small area of land? YES (NO)

Are there specific sites you may have in mind if funding was made available next spring? YES (NO)
Examples?

If Yes, Describe Practice: ____

Location: ____ Twp. ____ Sec. ____

Other Notes: Very active, conservation minded landowner. He would not likely participate in the land he owns within the Dobbins Creek area

Dobbins Creek Landowner Survey

The CRWD is working on a study to evaluate land use practices in the Dobbins Creek area. There have been extensive studies in this area which show that there are concerns with the level of sediment getting into Dobbins creek. There are also resource concerns involved with numerous flood events. Dobbins is a very flashy watershed. In the past, it has been hit with heavy rain events which move very quickly over the land with a great deal of velocity. These events result in a variety of flood damage issues. We have unique opportunity to review the watershed in detail and look at specific best management practices could be used to alleviate some of the water quality and flood damage a problems. I will be asking a series of questions, trying to get an understanding of what BMP practices you may be interested in incorporating into your operation. We will have an excellent opportunity to offer a "taylor made" cost-share program to fit the needs of the producers in this area.

Name: Gene Tapp Twp. Red Rock Sec. Various

Have you ever enrolled in a cost-share program for the following practices?

	Cost Share	On Own	Current Practice?
Wetland Restoration			
Flood Retention			
Stream Bank Restoration			
Buffer Strip			
Perennial Biofuel Crops			
Conservation Tillage	X		Expire in '09
Nutrient Management Incentive	X		

Which practice would you consider putting on your farm (if appropriately compensated)

Wetland Restoration	
Flood Retention	X
Stream Bank Restoration	X
Buffer Strip	
~~Perennial Biofuel Crops~~	
Conservation Tillage	X
Nutrient Management Incentive	
Other	

Description: ______

What kind of incentives would it take for you or your neighbors to incorporate some of these practices?

"High enough monetary incentives"

Would you be open to Land Retirement Programs? (YES) NO

If Yes – Would you prefer Easements or Land Sale? (Easements) Land Sale

Would you be open to Flowage Easements to temporarily impound water on a small area of land? (YES) NO

Are there specific sites you may have in mind if funding was made available next spring? (YES) NO
Examples?

If Yes, Describe Practice: Conservation Tillage, Stream Bank, Flood Retention

Location: Various Twp. ______ Sec. ______

Other Notes:

Site #2
Feasibility Study

Dobbins Creek Landowner Survey

The CRWD is working on a study to evaluate land use practices in the Dobbins Creek area. There have been extensive studies in this area which show that there are concerns with the level of sediment getting into Dobbins creek. There are also resource concerns involved with numerous flood events. Dobbins is a very flashy watershed. In the past, it has been hit with heavy rain events which move very quickly over the land with a great deal of velocity. These events result in a variety of flood damage issues. We have unique opportunity to review the watershed in detail and look at specific best management practices could be used to alleviate some of the water quality and flood damage a problems. I will be asking a series of questions, trying to get an understanding of what BMP practices you may be interested in incorporating into your operation. We will have an excellent opportunity to offer a "taylor made" cost-share program to fit the needs of the producers in this area.

Name: Joseph Guiney Twp. Red Rock Sec. 28

Have you ever enrolled in a ~~cost-share~~ Conservation Program program for the following practices?

	Cost Share	On Own	Current Practice?
Wetland Restoration	X		
Flood Retention			
Stream Bank Restoration			
Buffer Strip			
Perennial Biofuel Crops			
Conservation Tillage			
Nutrient Management Incentive			

Which practice would you consider putting on your farm (if appropriately compensated)

Wetland Restoration	
Flood Retention	
Stream Bank Restoration	
Buffer Strip	
Perennial Biofuel Crops	
Conservation Tillage	X
Nutrient Management Incentive	
Other	

Description: Native Cost-Share Program Perenial Hay Crop

What kind of incentives would it take for you or your neighbors to incorporate some of these practices?

[illegible] Not sure what incentives would be needed for others.
[illegible]

Would you be open to Land Retirement Programs? (YES) NO

If Yes – Would you prefer Easements or Land Sale? (Easements) Land Sale

Would you be open to Flowage Easements to temporarily impound water on a small area of land? (YES) NO

Are there specific sites you may have in mind if funding was made available next spring? (YES) NO
Examples?

If Yes, Describe Practice: [illegible] Flood Retention, Conservation Tillage

Location: ______ Twp. Red Rock Sec. 28

Other Notes:

East - of proposed site in "Site #2" Landowner may be interested in additional retention Areas.